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PIPE LINE INDUSTRY

OCTOBER
1961

Construction Progress

California-Alberta Line has top engineering design and smart contractor ideas all the way • Most of 1,240 mile, 36-inch main line was internally coated • Extensive use was made of railhead double-jointing and coating plants for high quality construction • Advance rock survey • Automatic welding • Latest station designs • New pipe protection ideas are just a few of the advances p. 36

Also first report . . .

West Shore Squeezes Through 285 Congested Miles p. 58

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CONTROL NOTES
Fundamentals of Data Transmission 47

NEW COLUMBIUM PIPE
XC-60 Passes First Field Tests Well 50

HURRICANE REPORT
Gulf Coast Lines Withstand "Carla" 64

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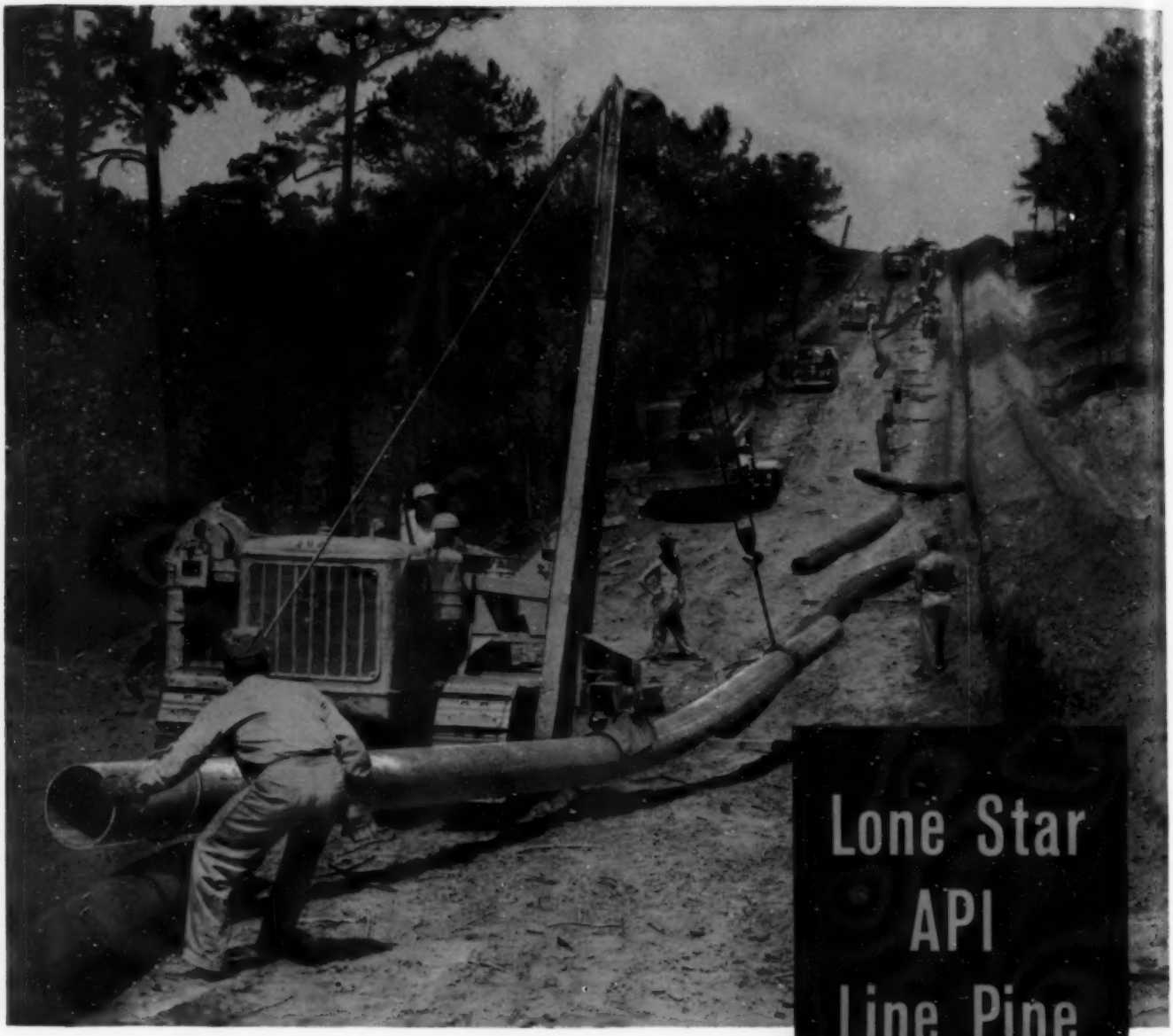

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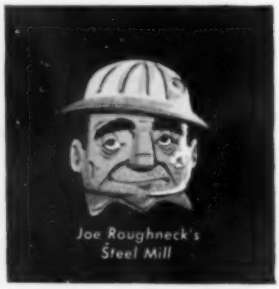

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PIPE LINE INDUSTRY

A GULF PUBLISHING COMPANY PUBLICATION

October 1961 Vol. 15, No. 4

CONTENTS
and Quick Look

To help you put first things first, scan these time-saving digests, checking ✓ those you want to read first.

Welding new XC-60 pipe
page 50

On the West Shore line
page 58

Tracking Hurricane Carla
page 64

Canada-California Line Sets Some New Records

☐ In laying the 1,240 miles of 36-inch main line plus more than 200 miles of smaller pipe, contractors set a record construction pace. Western-Neill's joint venture laid 86 miles in one 24-day working period. Most of the mainline was internally coated with an epoxy system which should save an estimated $7 million in horsepower outlay. Plans call for 16 remotely operated stations. Four are now under construction. New construction ideas include first test of an on-the-line automatic welder, highly automated double-jointing and coating field plants and several rock ditching and pipe protection techniques.

By Melvin A. Judah and Donald G. DePugh ..... **Page 37**

Data Transmission Simplified (Part 1)

☐ Have you ever wondered about such terms as *baud, bits* or *binary?* Here's an explanation of the argot terms used in digital telemetering, told in simple language for non-electronic pipeliners.

By F. Vinton Long ..... **Page 47**

Advantages of the New XC-60 Pipe

☐ After laying some 50 miles of 20, 24 and 30-inch pipe, Natural Gas Pipeline Company says the pipe could effect savings up to $6,000 per mile in 26-inch diameter lines. The pipe has 60,000 psi minimum yield, 78,000 psi ultimate and it can be welded at subzero temperatures without pre-heat. It retains a ductility equivalent to that of mild steel.

By A. G. Barkow ..... **Page 50**

West Shore Line Squeezes Through Congested Areas

☐ This new products line from the Chicago area to Milwaukee and Green Bay, Wis., has more than 500 cased crossings. It threads between railroads and highways, and when it reaches open country, rock and peat bogs hampered pipeliners.

By Melvin A. Judah ..... **Page 58**

How Pipeliners Came Out With Carla

☐ It probably was the worst storm of the century, but it found pipeliners ready for it. One weather scientist points out two factors which can save your life in time of a hurricane.

By Donald M. Taylor ..... **Page 64**

REGULAR MONTHLY DEPARTMENTS

Editorial Page	4	Who's Meeting Where	75
Pipe Line Panorama	35	Service and Supply Men	76
Ideas for the Future	57	Classified Advertising	80
Pipe Line Hints	66	What's New in Equipment	82
Construction News	67	New Equipment Literature	91
Pipe Line Men in the News	72	Advertisers' Index	94

New Direction in Gas Regulation

INTEREST WAS INTENSE as more than 500 leaders of the U.S. gas business packed into the Shamrock Hilton's Continental Room. The next speaker was to be the top "umpire" in the gas game. Joseph C. Swidler, new chairman of the Federal Power Commission, titled his first public policy discussion "New Directions In Gas Regulation."

Joseph C. Swidler

After reading an advance copy of his scheduled address before the INGAA (an editor's rare privilege so he might be able to ask an intelligent question in the press conference that followed) we couldn't help but think that the title was slightly in error. Chairman Swidler's message was not so much new in *azimuth* but his remarks indicated definite changes in the "attitude" that the "new commission" will have toward its work of "directing" the relationships within the gas industry. That thinking, apparently, is that the commission will not just take on the task of solving a specific regulatory matter when forced into it; instead it will be seeking enthusiastically every regulatory means for carrying out the Natural Gas Act to make the FPC the central guiding force for all sectors of the gas industry.

Here are some key points which seem to best reveal Chairman Swidler's attitude toward regulation.

FPC Function. "The commission has an important role to play in the industry's future . . . work of the commission is as full of important, live and pressing problems as one could hope to find anywhere. These are problems which cry for energetic and imaginative treatment . . .

"Upon consumer confidence . . . the whole success of the industry depends. All elements of the industry must work together to instill and maintain a justified sense of complete assurance in the adequacy and continuity of natural gas supply, and at a price which will preserve its status as a fuel which is not only convenient and dependable, but inexpensive as well . . . "Rate decisions of the commission have an enormous economic impact, and they must be made with the most sober care for fair dealing as between producers and consumers."

Area Rate Proceedings. "On no subject in the gas industry is there more intense interest than in the question of the future course of the area rate proceedings. My own present view is that the area rate proceedings will probably prove to be the most important single tool for developing a sound frame-work of producer rate regulation . . .

"I do not believe the production of natural gas lends itself readily to an individual well by well or even company by company cost of service and rate of return approach. The independent producer risks his money . . . in the hope of a large reward if he is successful. . . I fully realize that gas is not available until it is discovered and that there must be an incentive for discovering more and more gas if the industry is to remain healthy I do not delude myself that simply recovering costs plus a 6 percent return on investment is a sufficient incentive . . ."

Speeding Up Cases. "A continuing problem of regulation is to avoid needless uncertainty as to Commission policies. Such uncertainties add to the caseload, stimulate litigation, and waste the time of everybody concerned. I hope that the Commission can turn to the increased use of policy statements to express Commission policies . . . We shall attempt to leave no doubt in the future as to the basis for our decisions . . ."

Third Party Intervention. "A good deal of the natural gas litigation has been initiated by third party interests who were not confident as to the Commission's ability to protect the public interest. I hope their confidence will grow and that the Commission's dedication to the protection of the paramount public interest will become so clear that it will not be necessary for third parties to intervene in the future to the extent that they have felt required to do so in the past."

In-Place Purchase of Gas Reserves? "If that became the predominate method of acquiring reserves, and were to be excluded from Commission authority, then it would in effect repeal the Phillips Decision."

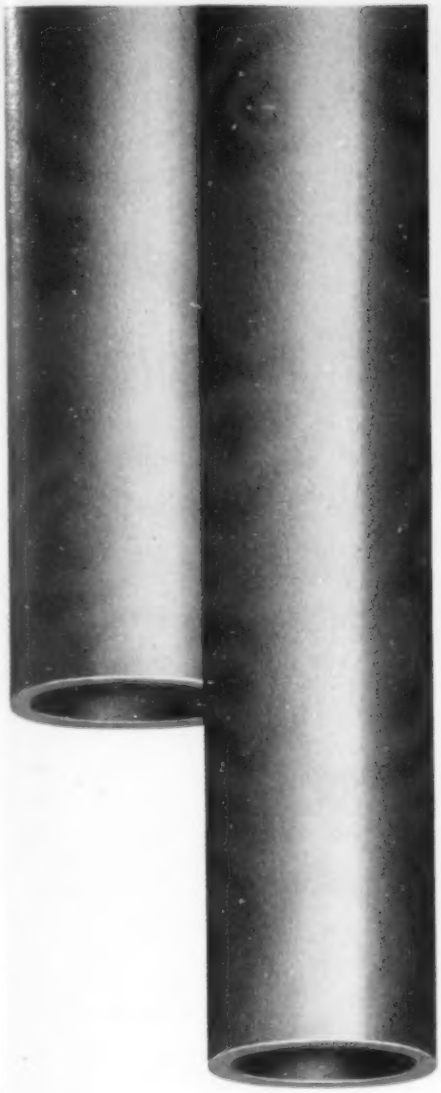
AGA Studies for Future Gas Needs? "This seems to be a very sensible thing . . . to see what we have on our shelves and how many purchasers we have and will have."

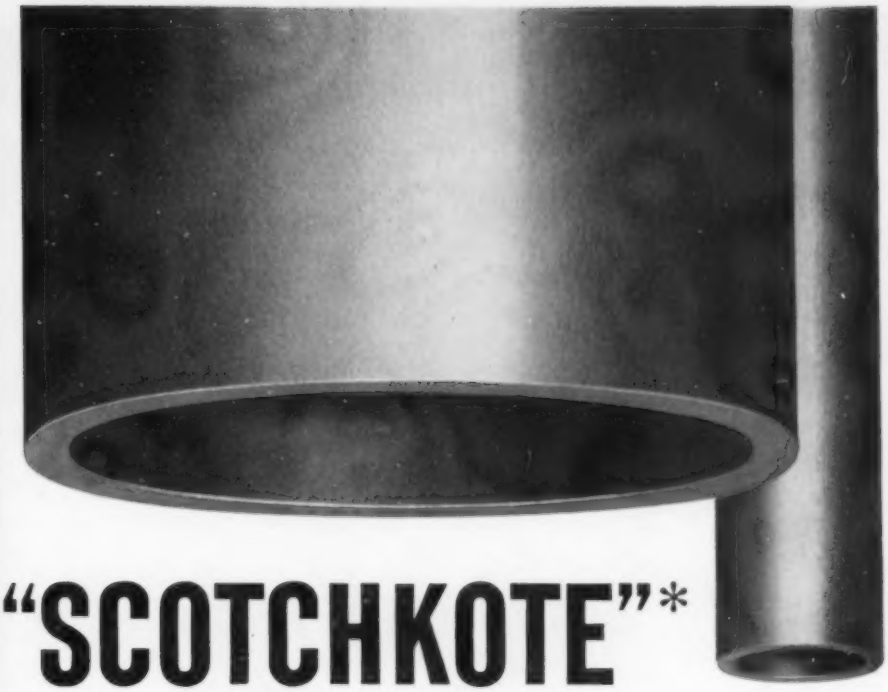
Industry reaction to Swidler's speech was generally "not pessimistic." Many leaders felt that effort was going to be made to speed up the work of the Commission, to reduce the docket and to spell out working procedures that would better let all sections of the industry know where they stand and in general "to expedite the regulatory process."

Since none of the gas industry branches . . . pipe line, producer, distributor nor the consumer and the FPC, itself . . . want to go back to the woodbox, Swidler's theme of direction, dedication and purpose gives all something to be hopeful about. Time will tell how much success the new commission will have in its efforts.

The new FPC chairman appears to be an outstanding attorney who is learning the gas business rapidly; fortunately, he has a sense of humor for as he observed . . . "If the history of this agency is any criterion, one's official life is likely to be mercifully short."

Melvin A. Judah





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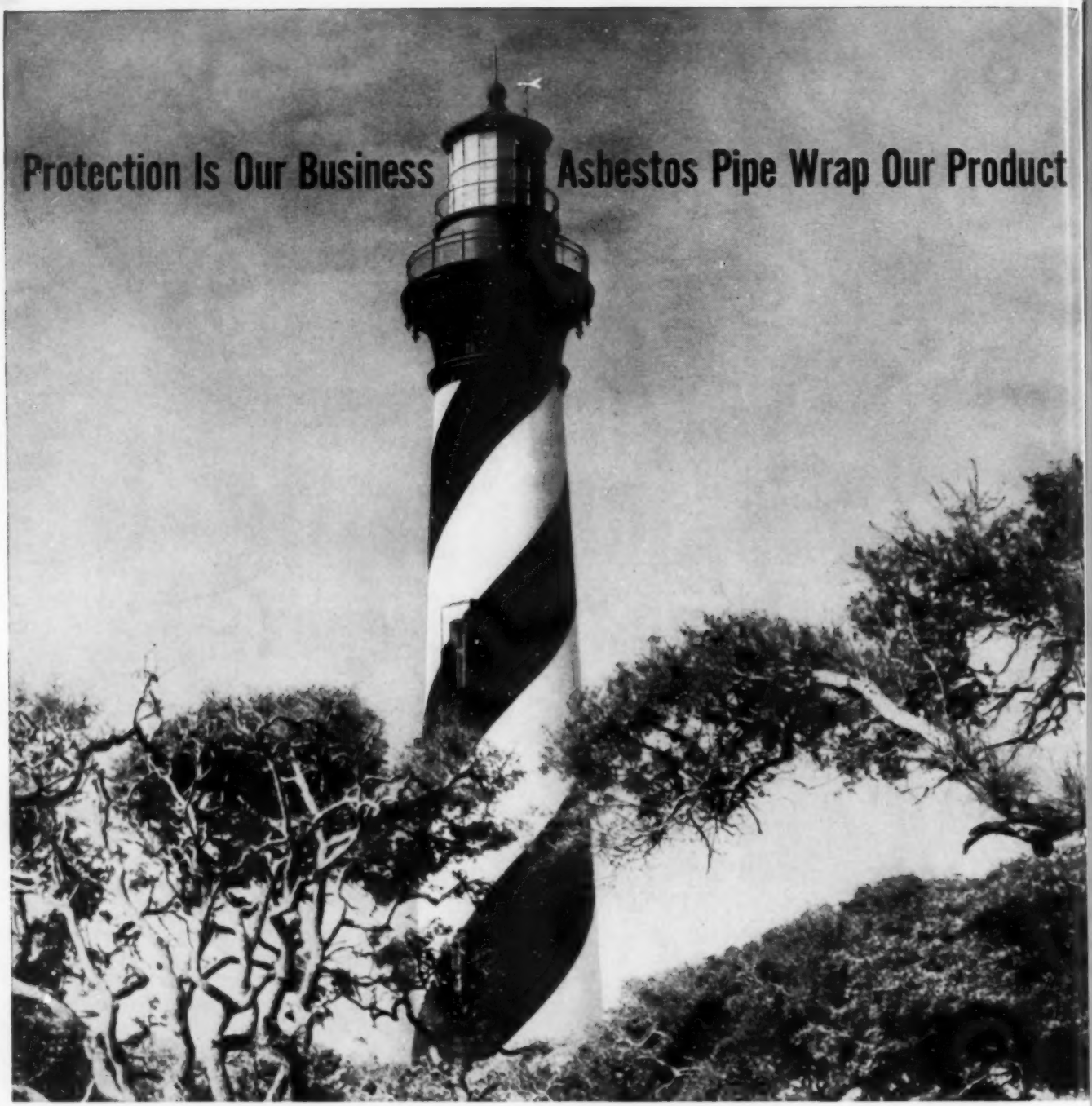

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Postmaster: Send notification (Form 3579) regarding undeliverable magazines to PIPE LINE INDUSTRY, Box 2608, Houston 1, Texas.

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Indexed by Engineering Index

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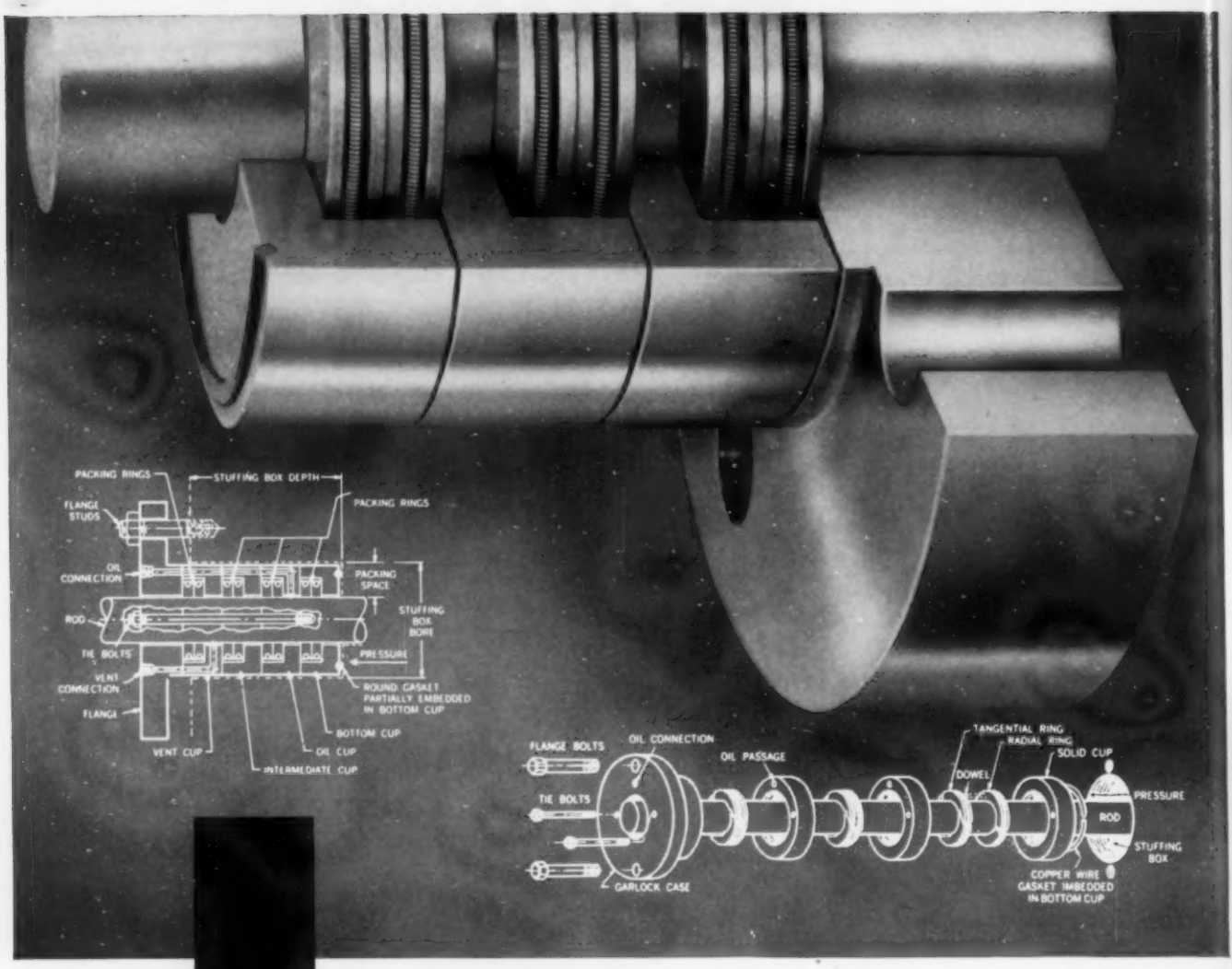

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Like most contractors today, Carl Rumage, owner of C. A. Rumage Co., Vernon, Texas, is fighting the squeeze on profits every way he can. He's found one of the best ways is to trade up for new, more productive machines—even if existing equipment is working fine. Two new D6B Tractors, recently purchased by this contractor, provide a good example.

Comparing the new D6 with the old D6, Carl Rumage says, "Our new machines do the work at least 30% faster . . . and they do it on less fuel! Trading up to the new D6 is sure paying off for us."

There's good reason for Mr. Rumage's enthusiasm. The new 93 HP Cat D333 Diesel Engine, for example, has 25% more lugging ability than the previous model. A more comfortable operator's compartment and convenient controls help keep operator efficiency high. A new hydraulic bulldozer, with quick-drop valves, gives faster operation, increased productivity.

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Trading up to new, more productive D6B Tractors certainly made sense for Carl Rumage. A similar trade may help solve your profit problem. Your Caterpillar Dealer can help you decide and can demonstrate the production advantages of new Cat-built machines. See him today.

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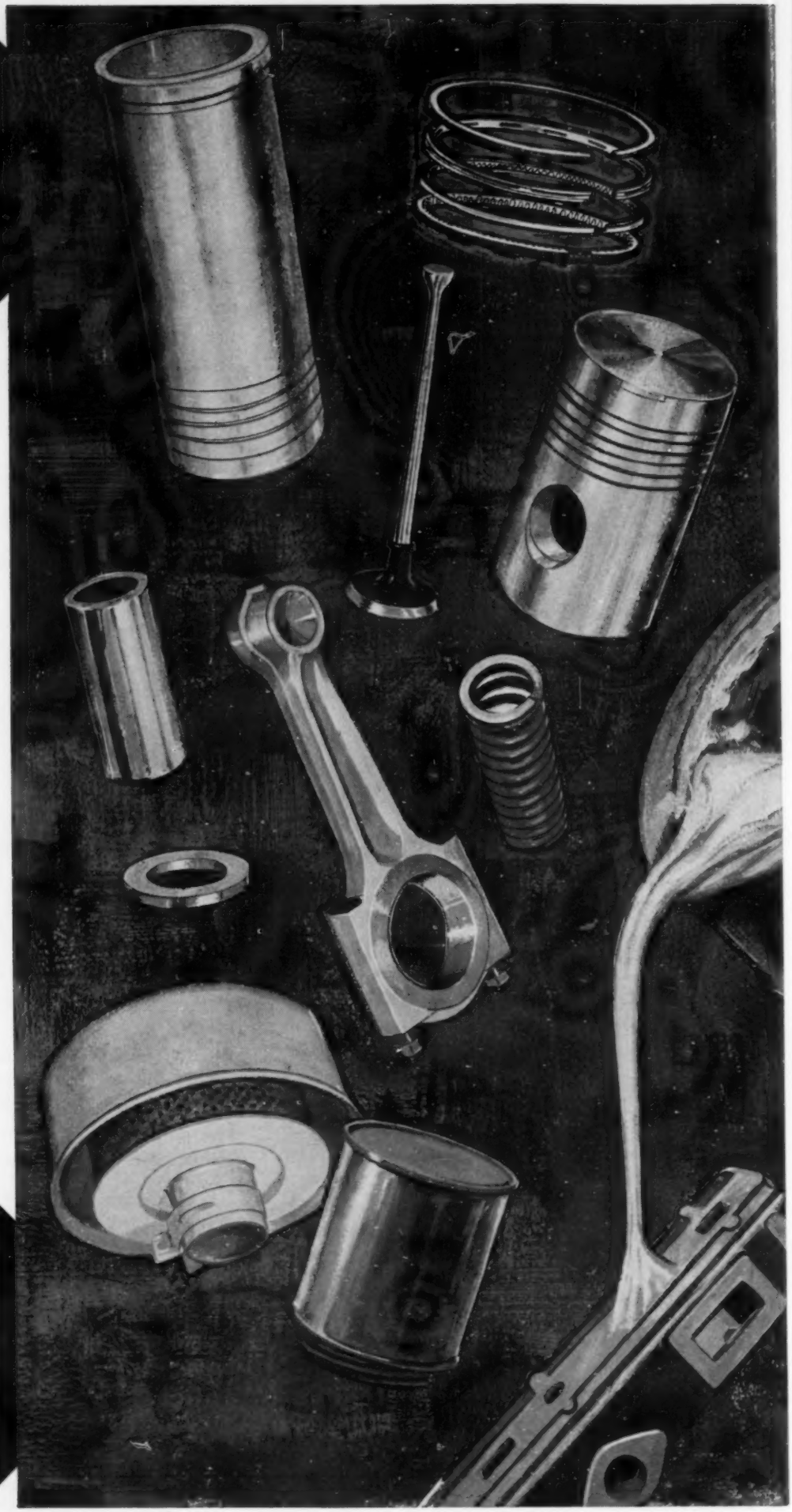

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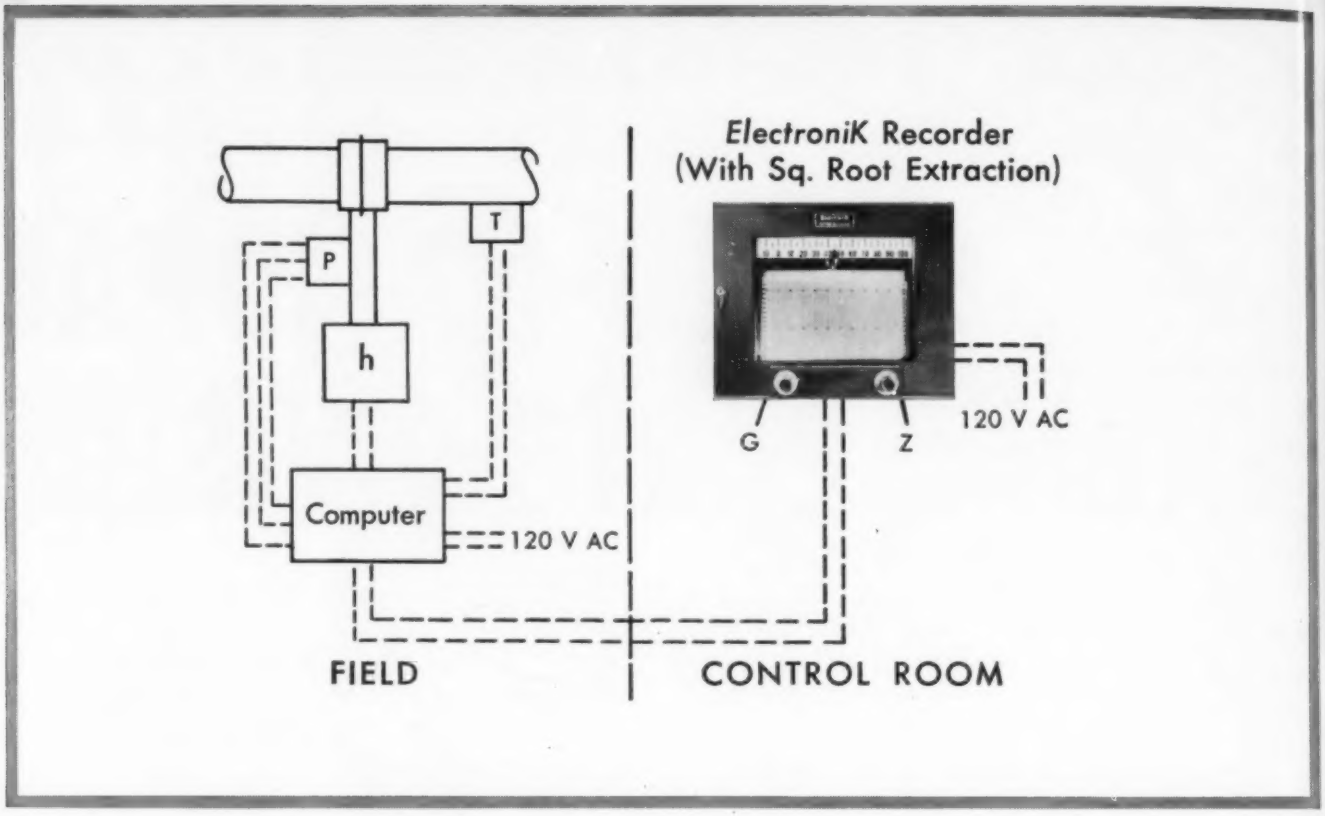

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$$Q = K\sqrt{\frac{hP}{TGZ}}$$

Where **Q** = mass rate of flow, scfh
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P = static pressure, psia
T = flowing temperature, °R, (°F + 460)
G = specific gravity
Z = super-compressibility
K = orifice flow constant

The *ElectriK Tel-O-Set* △P/I transmitter measures *h*; an absolute pressure transducer measures *P*; and a resistance thermometer bulb measures *T*. The analog computer multiplies *h* by *P* and divides by *T* . . . and sends a resultant millivoltage to the *ElectroniK* recorder. The recorder applies the correction factors G and Z, extracts the square root, and records the resultant mass flow Q.

Easily linked to telemetering and remote control systems, supervisory control, data handling and industrial process computers.

No more tedious, time-consuming calculation of gas flow. This versatile gas flow computer does it for you . . . automatically, continuously. It measures and records gas flow in terms of standard cubic feet per unit time, and is the only all-electric system of its kind.

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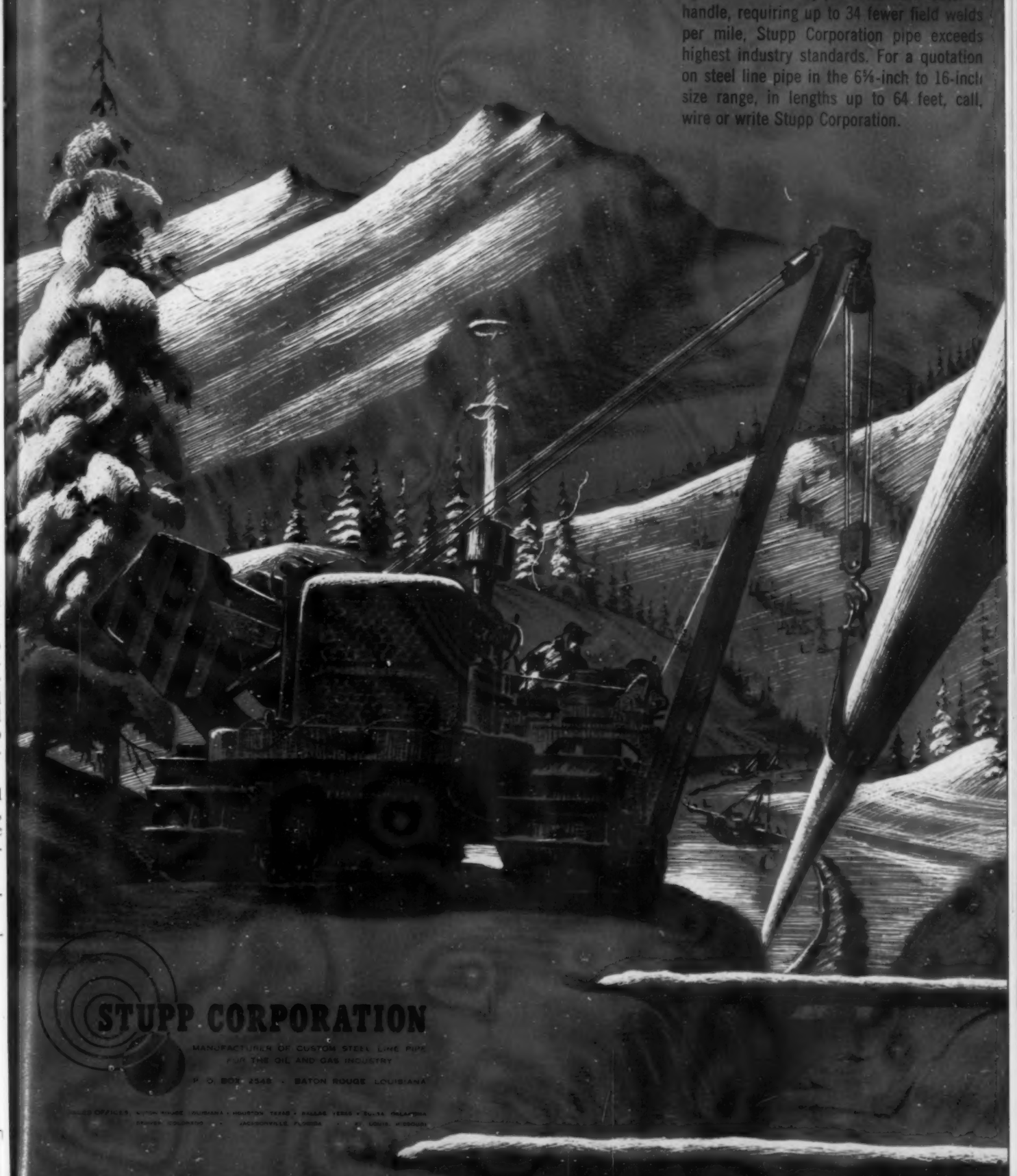

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Additional Jones & Laughlin tests and advanced mill practices guard the quality of J&L line pipe. The pipe is easy to bend, line up, and weld.

Ask for technical data and prices on J&L line pipe, Rockwell plug valves, and Taylor Forge welding fittings. If it's sold by J&L it's the best available. Call your local J&L Supply man—or write us at Tulsa, 1423 Sheridan Rd.

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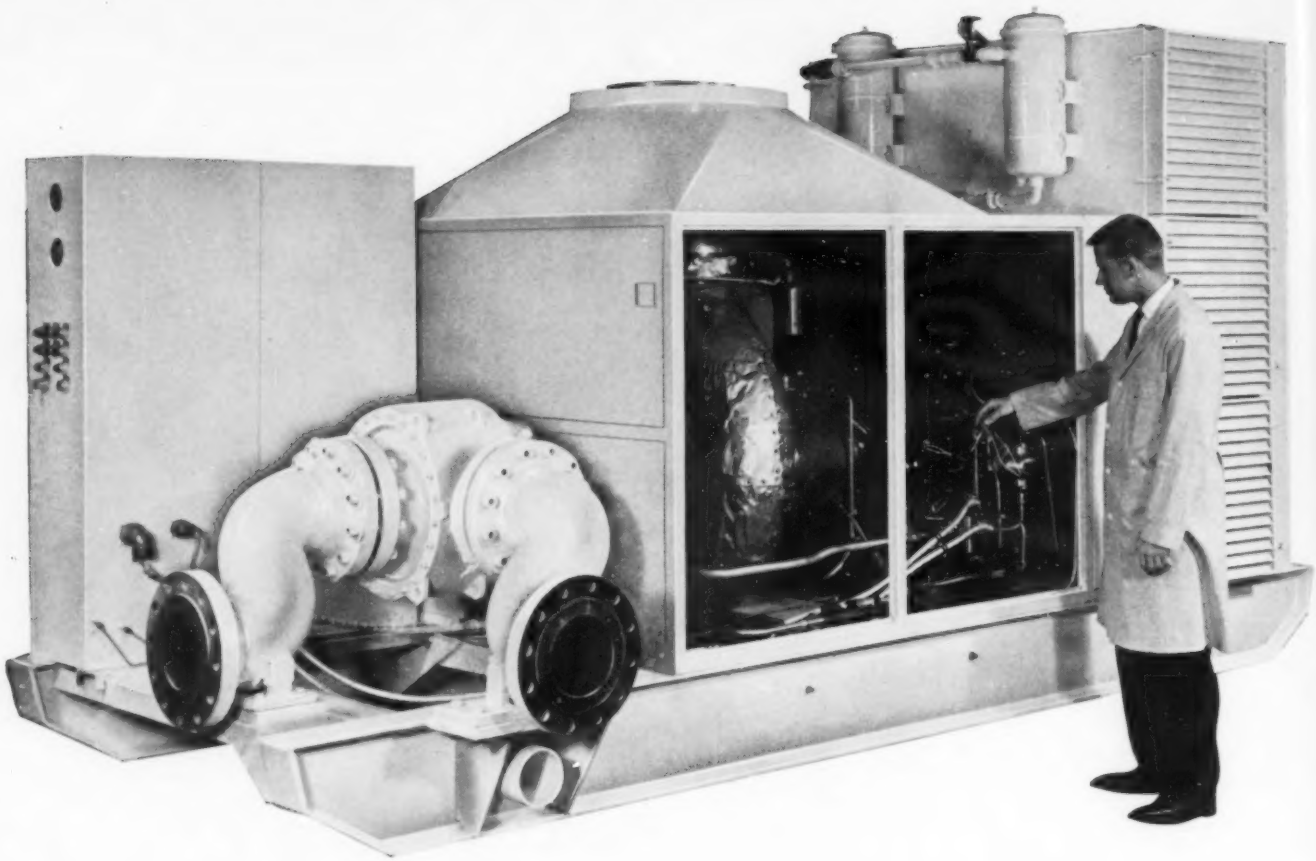
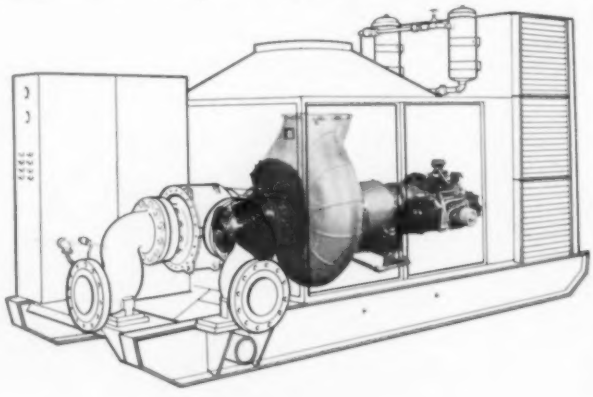


Solar gas turbine pumps provide compact, portable power in a wide variety of applications

Solar 1100 hp *Saturn* gas turbines are ideally suited for driving industrial pumps. Lightweight and compact, they are used in applications ranging from field boosting to a truck-mounted oil well fracturing unit.

Solar *Saturn* gas turbine-driven pumps are easily moved from job to job as requirements change. They can run on virtually any kind of fuel, including gasoline, diesel fuel, kerosene, natural gas and LPG fuels.

The *Saturn* engine is operating or scheduled for a number of pump jobs.



Phillips Pipeline Company has a *Saturn* gas turbine-driven pump at its El Dorado, Kansas, station. It provides up to 1900 gallons of liquefied products per minute at 2500 ft of head. This *Saturn* turbine-driven pump runs automatically on natural gas from the line on a continuous duty basis. It weighs just 7800 lbs. Comparable piston-driven units weigh between 50,000 and 75,000 lbs.

Mid-America Pipeline Company will use a *Saturn* turbine pump to increase propane capacity at the company's booster station near Whiting, Iowa. The unit is skid-mounted and will run on propane fuel taken from the pipeline.

Okan Pipeline Company has a *Saturn* gas turbine to drive a booster pump in its main pipeline, which carries liquid petroleum products. The *Saturn* gas turbine runs on liquid butane most of the time but is capable of running on other refined liquid fuels.

The Western Company has a *Saturn* gas turbine-driven fracturing pump designed to stimulate production of older oil wells. Mounted on a commercial bobtailed truck, the *Saturn* turbine-powered pump delivers 1000 hydraulic hp per unit over a wide range of volume-pressure ratios. Weight of the truck and fracturing unit is 15,000 lbs lighter than 600 hp diesel units used by Western, allowing for increased mobility.

Solar gas turbines start instantly in any climate and accept full load without warmup. The *Saturn* gas turbine is vibration free and requires no elaborate foundation. Simplified design assures easy, low cost installation and maintenance.

For further information write Solar, Dept. J-155, San Diego 12, California.

SOLAR

A subsidiary of International Harvester Company

722-MILE FINGER TIP COST CONTROL

for Pacific Gas Transmission Company
and Alberta Natural Gas Company

A solid state pipeline control system from Dresser Electronics, SIE Division,

will allow maximum personnel efficiency and optimum operation for the 722-mile Pacific Northwest portion of the new Alberta-California pipeline system.

Rock-steady reliability is guaranteed by use of transistors and semi-conductor diodes—no moving parts, **no known failure mechanism.** Digital "computer-language" techniques eliminate transmission errors, provide computer compatibility. Functional groupings of **plug-in modules** insure easy and logical maintenance—all Dresser/SIE system **users continue employing their regular maintenance personnel and key operating people.**

Continuous scanning—made possible only with infinite-life solid state components—verifies proper system functioning **at all times.** Data, status panels, and alarms **always current.** Automatic compressor start-up . . . speed and units-on-line determined by remote-set station discharge-pressure controller . . . speed and inlet-vane position control on centrifugal compressors . . . pocket-clearance computer-controller for rated-torque operation of reciprocating compressors—all these combine for **minimum horsepower per MSCF pumped.**

Accelerate your cost reduction program.
Call the pioneers in solid-state pipeline control...

Dresser/SIE equipment is also in use or being built for: Colorado Interstate Gas Company, Continental Oil Company (Cherokee Pipe Line Co.), Mountain Fuel Supply Company, Magnolia Pipe Line Company, Continental Oil Company (Glacier Pipe Line Co.), Tennessee Gas Transmission Company and Nordberg Engines.

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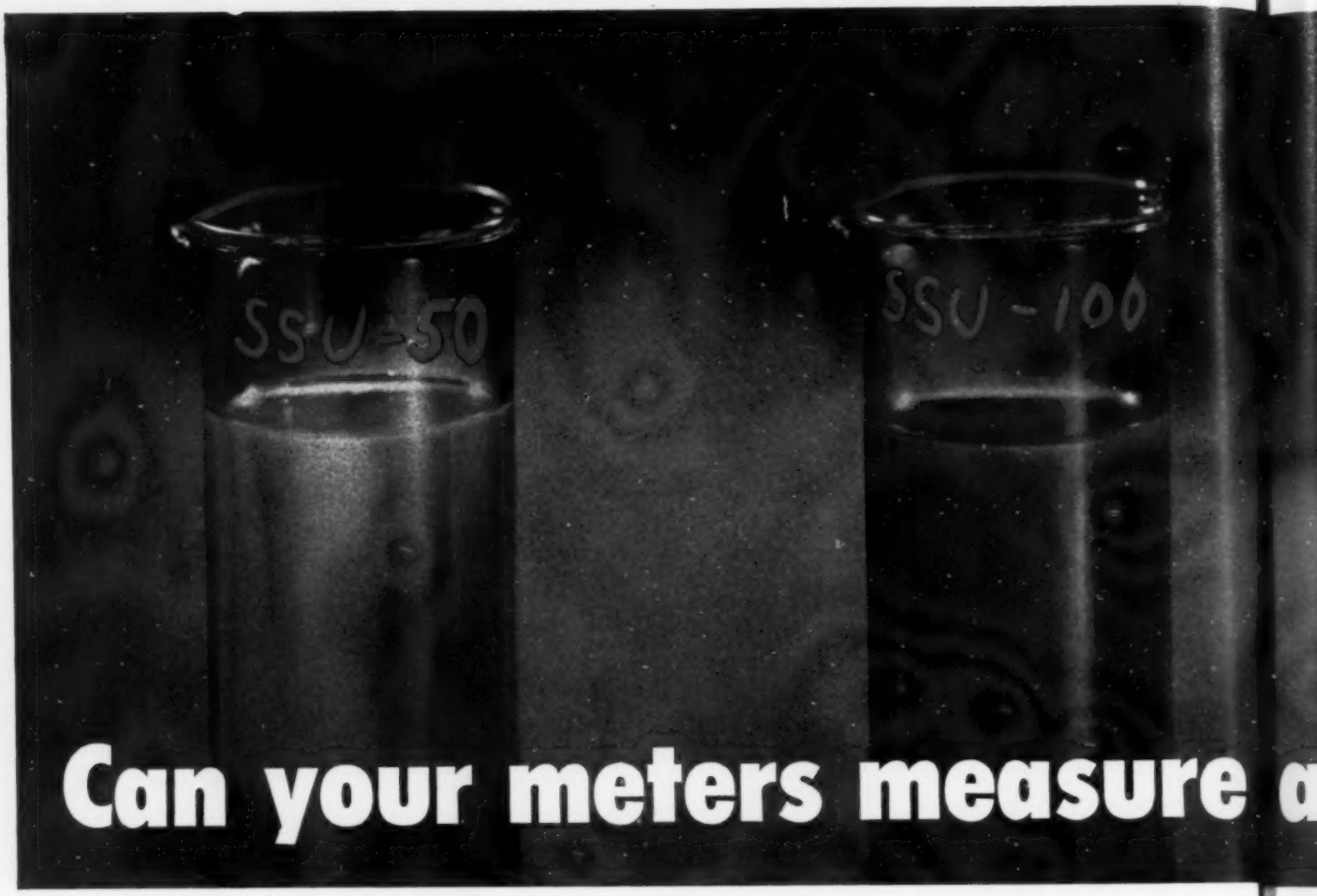
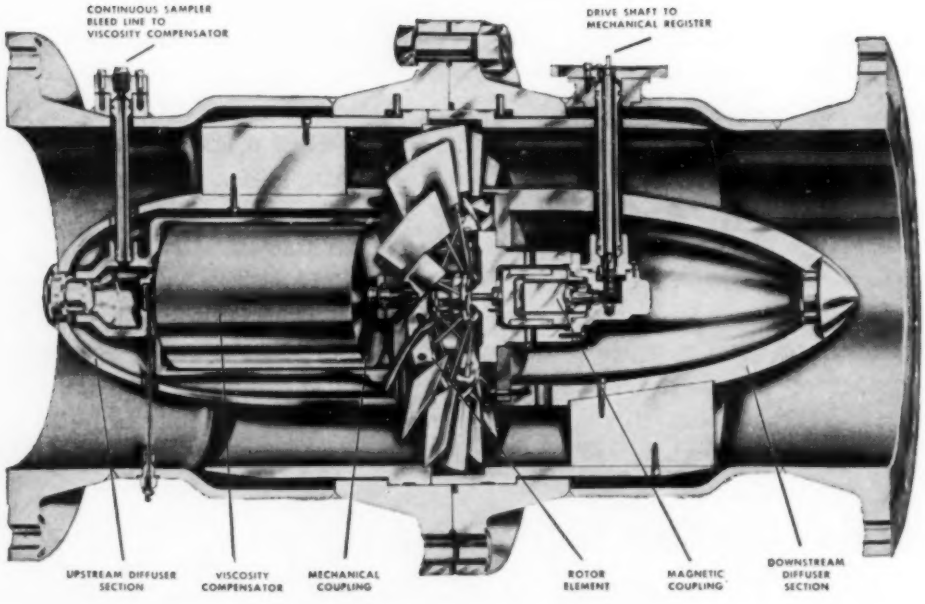
10201 Westheimer, Houston 42, Texas

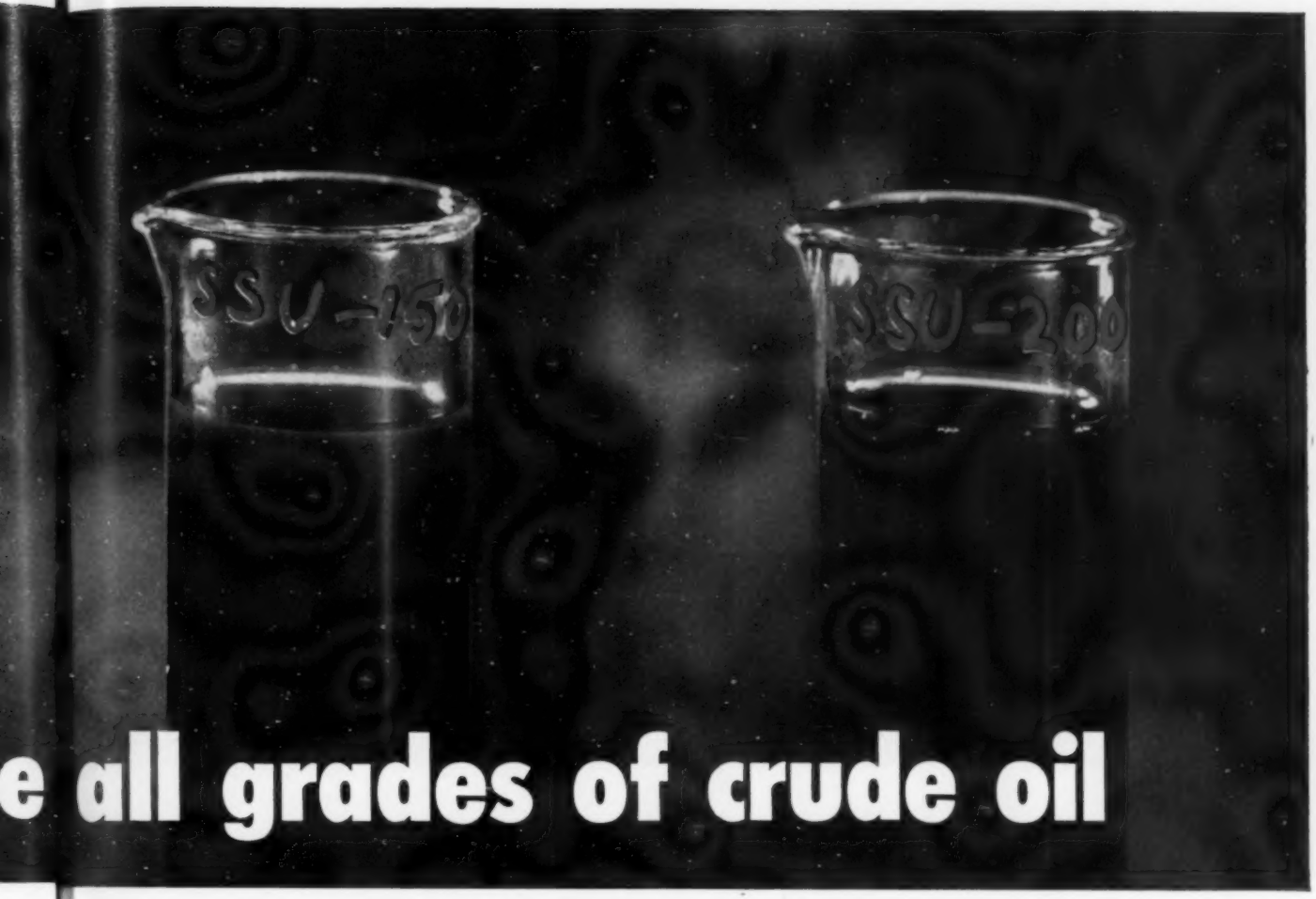


Can your meters measure a



Sectional View

ROCKWELL TURBO-METER

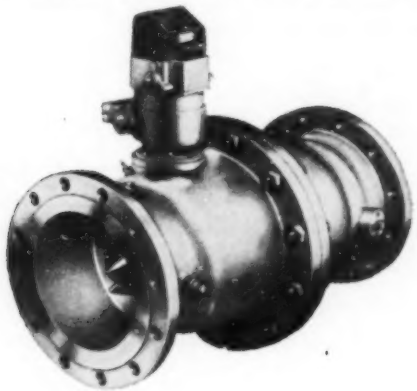


e all grades of crude oil

without recalibration?

ONLY ROCKWELL TURBO-METERS MEASURE BOTH THICK AND THIN LIQUIDS WITHOUT MANUAL ATTENTION

Product or temperature changes don't mean a thing to the accuracy of Rockwell Turbo-Meters. The same unattended meter will measure any hydrocarbon—from the heaviest crudes to light ends and piped products. A built-in viscosity compensator automatically makes the necessary corrections under continuous service conditions. All you do is read the meter. With optional remote registration you can even have "run" tickets from printing registers at your fingertips.



Another exclusive advantage is the wide range of flows that Turbo-Meters will measure with accuracy—all the way down to 20% of maximum capacity. For your convenience in checking their accuracy, provision is made for fast, in-line proving without interrupting the flow.

Before you buy any turbine type meter, get all the facts. See your Rockwell jobber or write us for bulletin PI-417. Rockwell Manufacturing Company, Dept. 125K, Pittsburgh 8, Pa. In Canada: Rockwell Manufacturing Company of Canada, Ltd., Box 420, Guelph, Ontario.

TURBO-METERS
another fine product by
ROCKWELL

SINCLAIR SPECIFIES ALLIED PIPELINE ENAMELS

Allied Standard Coal Tar Enamel was specified for Sinclair Pipe Line's new 8-inch crude oil line, stretching 178 miles from north of Oklahoma City to Woodward, Oklahoma.

Running this light wall 8⅝ inch coated pipe through Western Oklahoma's rough terrain meant sharp bends in some places. Allied Standard Coal Tar Enamel withstood these bends. This assures the company, the contractor, and the applicator that these enamels will *remain firmly bonded* to the pipe, even under the toughest conditions.

Trucks from the Allied Stroud, Oklahoma plant delivered the Allied Standard Enamel to Pipe Coating of Tulsa's two yard coating operations at Woodward and Oklahoma City. Each yard handled an 86-mile section of the line.

Project engineer for Sinclair Pipe Line was D. S. Kauffman. Pipeline contractors were: R. H. Fulton Construction Co. of Lubbock, Texas. Oscar Phillips, superintendent for the Woodward section of the line. And, Brodie Construction Co. of Amarillo, Texas. C. C. Corrigan, superintendent for the Oklahoma City section. Coating was done by Pipe Coating of Tulsa, Gaines Laster and Ivan Brunkow, owners.

For more information on the advantages of Allied Pipeline Enamels, write:

ALLIED MATERIALS CORPORATION

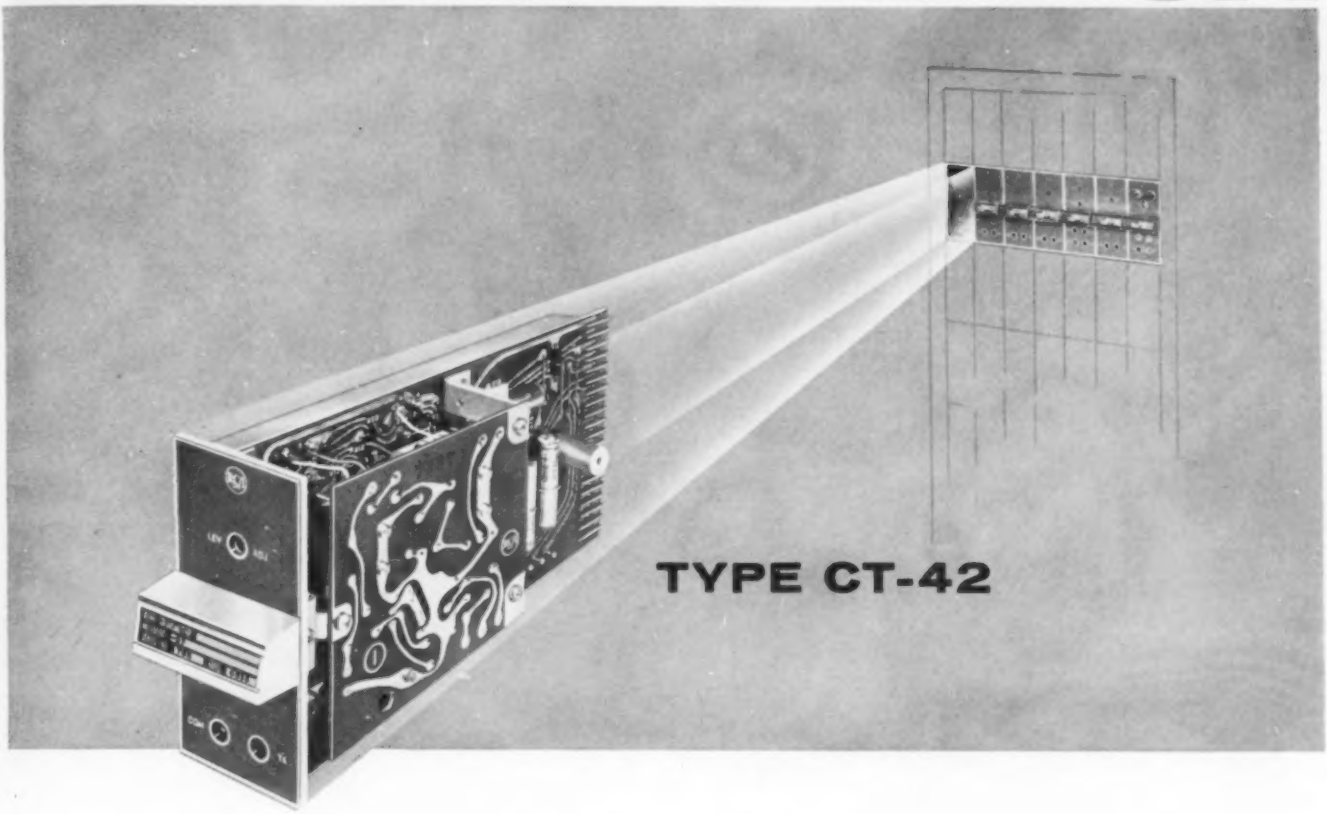
Producers, Refiners and Compounders of Special Asphalt and Coal Tar Products
Pipeline Materials Division, Mel Maddox, Manager

Allied Building • 5101 N. Pennsylvania • P. O. Box 7278—39th Street Station • Oklahoma City, Okla.
PLANTS: Stroud, Oklahoma • Detroit, Mich. • Los Angeles, Calif.

Allied Pipeline Enamels come from 29 years experience in the compounding of special coal tar and asphalt products.

ALLIED PIPELINE ENAMELS—COAL TAR BASE: **Allied Standard Pipeline Enamel • Allied Intermediate Pipeline Enamel • Allied Plasticized Pipeline Enamel • Allied Waterworks AWWA Enamel • Allied Special Enamel 250+.** COAL TAR PRIMERS: **Allied Coal Tar Primers • Allied Waterworks AWWA Primer • Allied Quick Dry Primer.** ASPHALT BASE: **Allied Pipeline Enamel** • ASPHALT PRIMER: **Allied Pipeline Primer.** COLD COATINGS: **Allied (Coal Tar) CA 50 • Allied (Coal Tar) CA 5.**

NEW... FROM RCA



SOLID STATE TONE MULTIPLEX

FOR WIRELINE, MICROWAVE OR CARRIER

24 channels from 420 to 3180 cps—Spaced every 120 cycles (CCITT Standards)
18 channels from 4300 to 7600 cps—Spaced 170 to 220 cycles

The CT-42 is an all new tone multiplex of high performance designed to operate over a wide environmental range. Ruggedly built, it uses computer grade components for lasting dependability.

Each channel can be frequency-shift or AM keyed for teletype, telemetering, control or data signals. Six transmitters or receivers in any combination may be plugged into a standard shelf which also contains a husky regulated power supply.

Channel units operate from 24 V DC or 117 V AC power supply.

If you are looking for the newest and best in tone multiplex equipment, mail the convenient coupon for complete specifications and prices.

The Most Trusted Name in Electronics
RADIO CORPORATION OF AMERICA

RADIO CORPORATION OF AMERICA
Microwave Equipment, Dept. A-418
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☐ Please send new catalog sheet and price list on Type CT-42 Tone Equipment.

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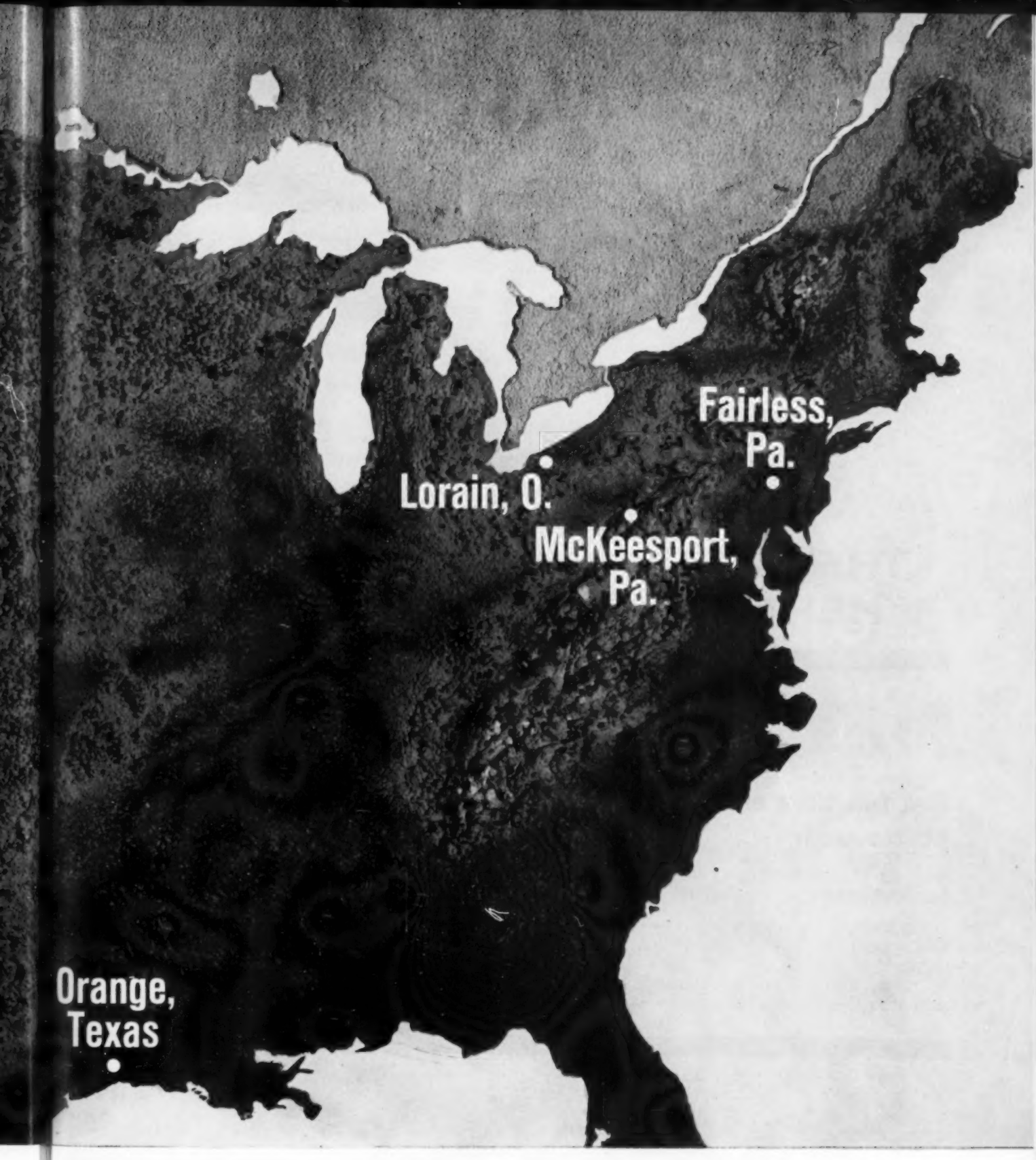
COMPANY_____

ADDRESS_____

CITY_____ ZONE_____ STATE_____

For more data on advertised products, use cards, last page.

Only USS National Line Pipe is made in so many places... and so well



Convenient to you—a complete range of grades and sizes of QUALITY line pipe, no matter where you are. These five pipe mill locations will give you excellent service.

*Consolidated Western Steel Division of United States Steel.

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National Tube Division of United States Steel

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors
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This mark tells you a product is made of modern, dependable Steel

EXCLUSIVE 100,000-MILE WARRANTY on 401-, 477- and 534-cu. in. Super Duty V-8's is the most liberal in the industry. Each major engine part (including block, heads, crankshaft, valves, pistons, rings), when engine is used in normal service, is warranted by your dealer against defects in material or workmanship. *The warranty covers full cost of replacement parts* for 100,000 miles or 24 months (or 3,000 hours if used as a power source for other than propelling the vehicle), whichever comes first . . . *full labor costs* for 50,000 miles, 12 months or 1,500 hours, sliding percentage scale thereafter.

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NEW '62 FORD TRUCKS

Get full-time economy that only starts with Ford's low price!

Meet the trucks that make saving money a full-time business—new Ford Trucks for '62!

In a selection of over 600 models there's a truck that's right for your job, whatever your job . . . trucks that you can buy and operate at lower cost . . . trucks that can save you money mile after mile, load after load, year after year!

They save on price. They save on gas and o They save on tires and on maintenance—wherev there's a way to save! The full record of Ford eco omy, covering three years of independent tests, detailed in Ford's Certified Economy Reports. S your Ford Dealer now. Check out the facts, wo out a deal, and drive out a truck that saves mon . . . full time!

FORD TRUCKS COST LESS

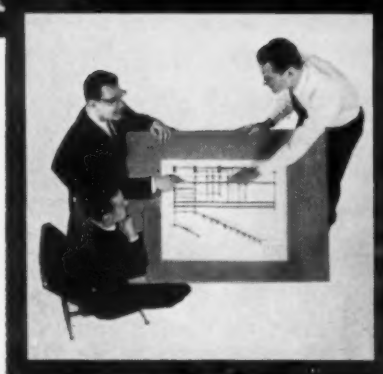
SAVE NOW . . . SAVE FROM NOW ON!

ECONOLINE — ALL-ROUND ECONOMY LEADER — and low price is only the start! Certified tests show this pickup may save $100 on gas, oil, tires, and license over your present conventional pickup every 16,000 miles you drive.

PROVEN 262-CU. IN. BIG SIX FOR FORD MEDIUMS includes more heavy-duty engine features than any other Six of its size. Never before such long-term durability, reliability, and economy at so low a price.

NEW STYLESIDE BODY FOR 4 X 4 PICKUPS—Ford's rugged 4-wheel drive models are now available with a cab-wide Styleside box that provides over 70 cubic feet of loadspace. Flareside body with running boards is also available.

PRODUCTS OF Ford MOTOR COMPANY



STROMBERG-CARLSON®
COMMUNICATIONS

The Stromberg-Carlson® approach to pipeline communication is practical, factual and sound. In the field of communications Stromberg-Carlson telephone experience dates back to 1894. Specialists are ready to sit down with your communication people in a practical "Pipedreaming" session to design a new system or revitalize an existing one for greater efficiency.

Using the "systems" approach, they can help you utilize the latest techniques and equipment to handle voice or data efficiently and at a cost no greater than buying "bits and pieces."

Design Analysis: Stromberg-Carlson product engineers can assist your own staff in creating the best and most economical system to meet your needs.

Experience: We are communication specialists, backed by over a half-century of serving the Independent telephone companies of America.

Product Quality: Rigid control of all manufacturing operations is your assurance that what we make is built to "telephone standards."

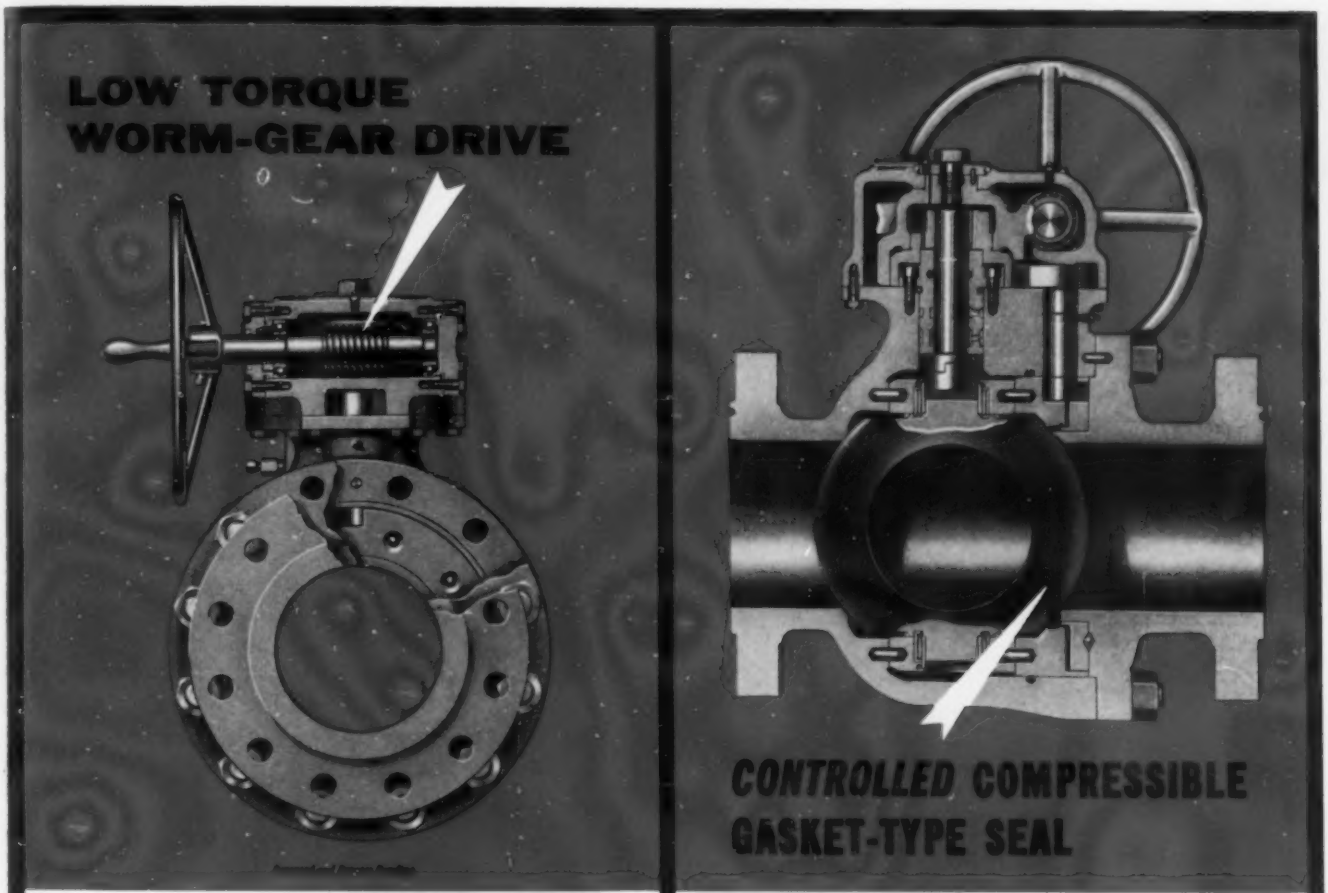
Product Research: A continuing program of research and product development to exploit the latest techniques of the communication art.

Modern Manufacturing: One of the most efficient manufacturing facilities in the country staffed by experienced craftsmen using the most modern machines.

To initiate a "Pipedreaming" session, at no cost to you, call or write to . . . Industrial Sales, Telecommunication Division, 127 Carlson Road, Rochester 3, New York. HUbbard 2-2200.

GENERAL DYNAMICS | TELECOMMUNICATION

Xtra benefits from full-opening HYDRIL Ball Plug Valves!



Now with worm-gear drive, Hydril Ball Plug Valves are even easier to operate... less torque on the handwheel is required than in other worm-gear valve drives. The ball plug is mounted on sealed bearings to further assure easy operation. Gear mechanism is completely enclosed for protection from weather and other damage. Optional power operators (pneumatic, hydraulic or electric) are available. Also available are the standard Hydril Ball Plug Valves with spur-gear drive. Both in a wide range of sizes and pressure ratings.

Like the gasket seal in a tongue-and-groove flange, the fully confined Hydril seal ring *does not rely on line pressure*... it is *mechanically compressed* against the plug to form a completely bubble-tight high-pressure seal in either direction. On opening the valve, this seal is relaxed from contact with the plug before it is turned. Friction and drag are minimized, assuring long life and low maintenance. Hydril Valves are fully field-tested and proven in a wide variety of services. See your Hydril representative, or write for new catalog.

HYDRIL COMPANY

714 West Olympic Boulevard, Los Angeles 15, California

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HYDRIL COMPANY: Bakersfield, Los Angeles, Ventura, California; New York, New York; Youngstown, Ohio; Rochester, Pennsylvania; Corpus Christi, Dallas, Houston, Midland, Odessa, Texas.

HYDRIL SUPPLY COMPANY: Harvey, Lafayette, New Iberia, Shreveport, Louisiana; Oklahoma City, Tulsa, Oklahoma; Casper, Wyoming.

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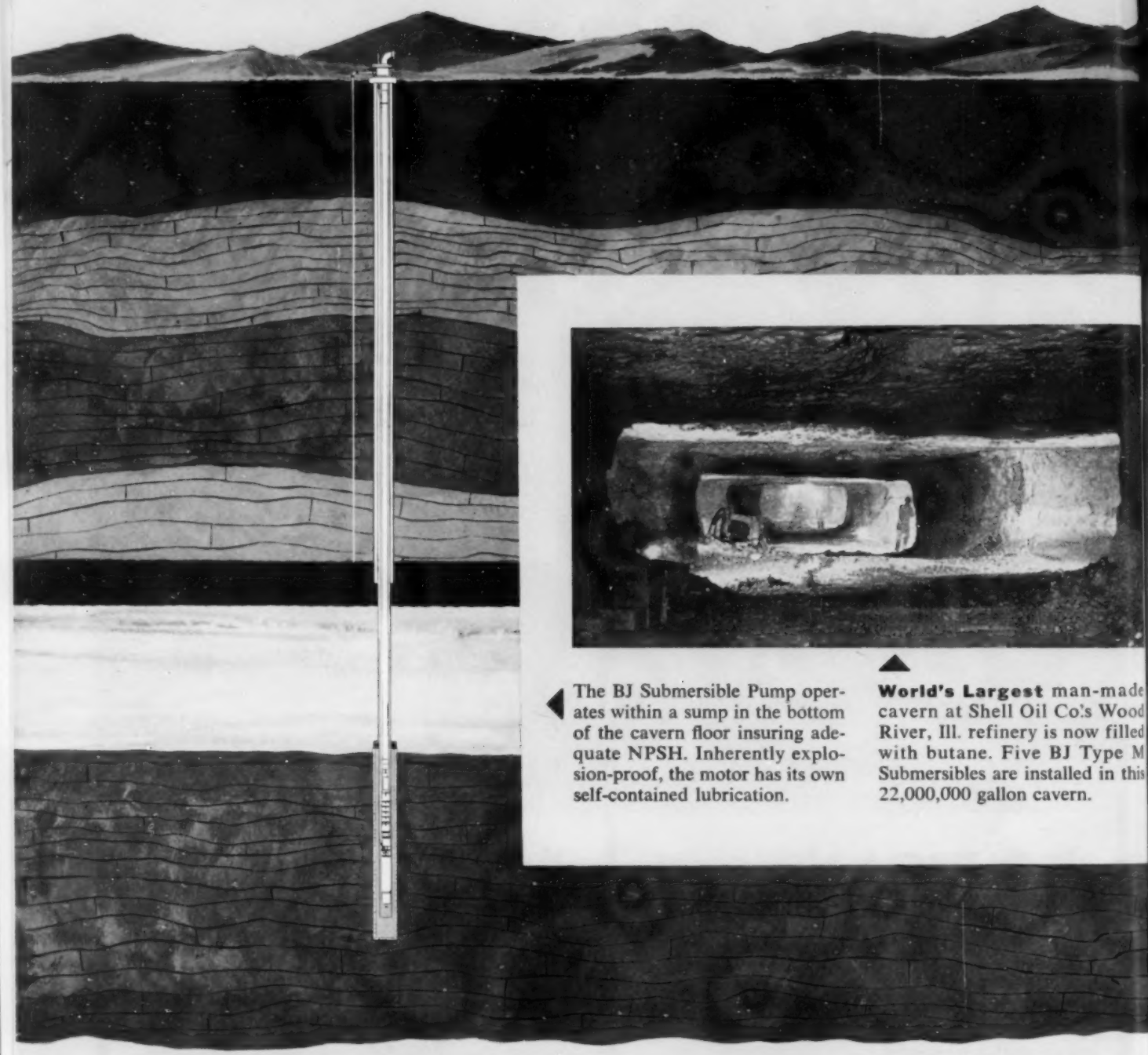
For more data on advertised products, use cards, last page.

BJ Submersible Pumps for Underground Cavern Storage..



The BJ Submersible Pump operates within a sump in the bottom of the cavern floor insuring adequate NPSH. Inherently explosion-proof, the motor has its own self-contained lubrication.

World's Largest man-made cavern at Shell Oil Co.'s Wood River, Ill. refinery is now filled with butane. Five BJ Type M Submersibles are installed in this 22,000,000 gallon cavern.

Underground cavern storage of Liquid Petroleum Gases has not only proved practical, but economical (approximately 20% of the cost of conventional surface storage).

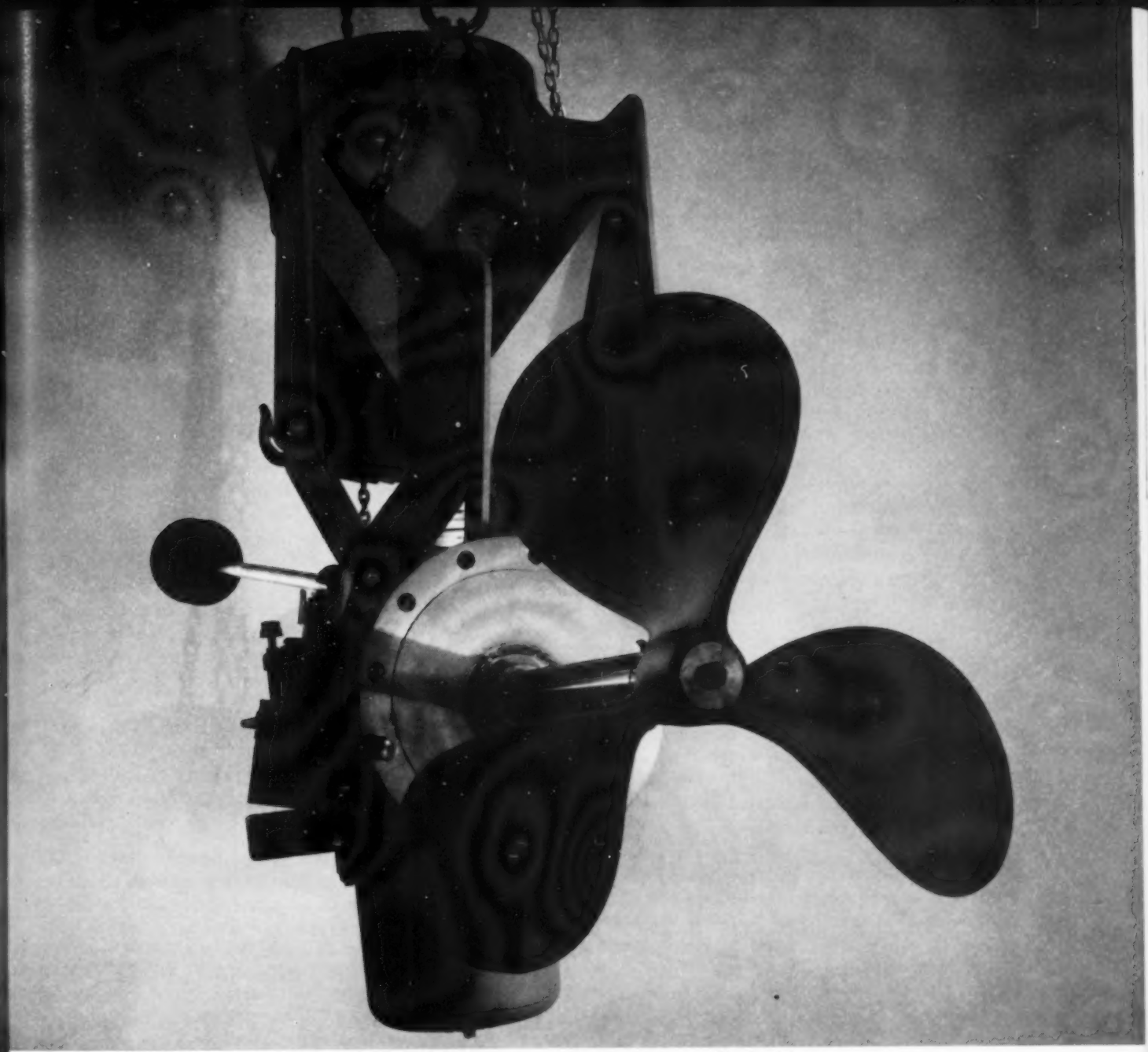
To meet the special requirements of this service, Byron Jackson has developed the Type "M" Submersible Pump. Using an oil filled, mechanically-sealed submersible motor, and a deep well bowl assembly designed especially for handling LPG, this pump has been proved in seven different cavern installations using a total of 14 pumps.

Sizes of these BJ Submersibles range from 4 to 16 stages, delivering from 40 to 800 gpm and rated at from 25 to 200 horsepower.

For a technical bulletin giving complete information on pump selection, installation and construction, plus a list of users, call or write BJ today!

BYRON JACKSON PUMPS, INC.
SUBSIDIARY OF BORG-WARNER CORPORATION
P.O. Box 2017A, Terminal Annex, Los Angeles 54, California

BYRON BW JACKSON
BORG-WARNER



Now—keep tanks clean with less installed power

This side-entering mixer will deliver up to 50% more fluid flow per horsepower.

It's one of the new series of LIGHTNIN Mixers—a Hi-Flo line especially designed to handle the big jobs economically.

These new mixers give you extra pumping capacity. More *usable power* for every unit of power input. You save on power load, on hookup, on installation costs . . . yet you get the same—*or better*—sediment control.

For example: one LIGHTNIN 40-hp unit will do the job of three conventional 20-hp mixers. A LIGHTNIN 20-hp unit will do more than the conventional 25-hp mixer. In most cases you can use a 15-hp LIGHTNIN unit where previously you've required 25 hp. The savings in initial cost, installation and operation really mount up.

Get details now. You get economy and performance like this only with the new LIGHTNIN Side Entering Mixers. The hollow-quill NSE series with independent shaft support; the brand-new RSE series with the mixer shaft directly connected to the speed reducer; and the V-belt-driven VSE series.

For details, just call your LIGHTNIN Mixer representative. He's listed in Pipe Line Catalog and in the yellow pages of your telephone book. Or write directly to us for Bulletin B-526.

Send me your Bulletin B-526 describing the new line of side-entering mixers. (For prompt attention, clip and mail this coupon with your name, title, company address.)

Lightnin® Mixers

MIXCO fluid mixing specialists

MIXING EQUIPMENT Co., Inc., 196-k Mt. Read Blvd., Rochester 3, N. Y.

In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Ave., Toronto 19, Ont.

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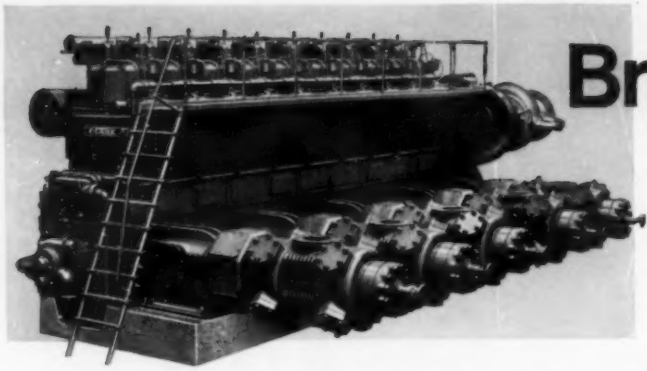


Breakthrough in tw variable spee

Automatic ignition timing plus automa turbocharger control provide unriva speed, load and response characteristi

Q. What makes two cycle engines so well suited variable-speed, variable-load applications?

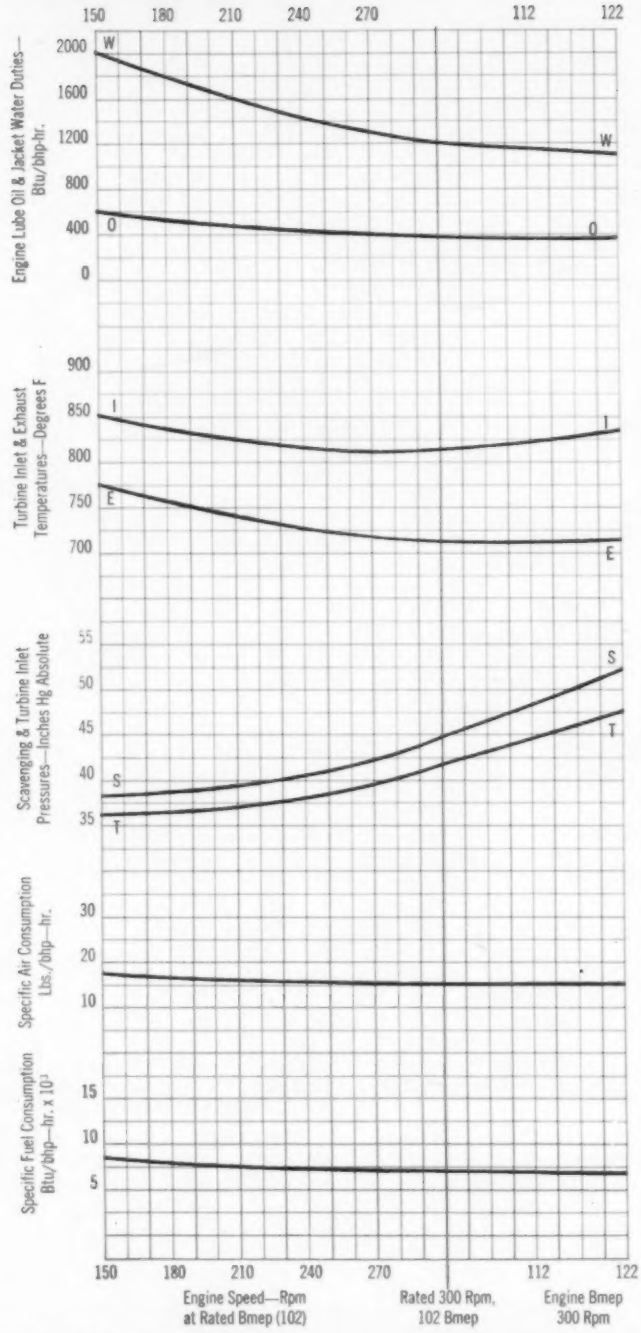
A. It has long been traditional to consider two cycle eng as good prime movers for applications where power speed are maintained close to 100% of rated load and sp This may have been true a number of years ago when cycle engines were single and twin horizontal designs. the situation began to change with the introductio vertical, multicylinder machines with direct fuel inject Subsequent addition of constant pressure turbochar and automatic ignition timing control have made two c performance equal or superior to four cycle engine acceleration and in response to load or speed changes. gardless of how fast the load or speed changes, the cycle engine is able to adjust more rapidly because it twice as frequently. As a result the actual amount of change between successive firings is cut in half, all o conditions being equal.

Q. Why has turbocharging caused such a vast impro ment in two cycle engines?

A. The Clark system of constant pressure turbochar permits variation of scavenging air flow with load to m tain relatively uniform air/fuel ratios over the comp operating range. This variable air supply plus maintena of optimum ignition timing enables Clark engines to achi excellent performance from substantial temporary overlo at rated speed down to the usually recommended 50% sp at constant torque.

Q. Why is constant pressure turbocharging so effecti

A. In general, all turbocharged engines are arranged achieve best efficiency and fuel consumption at a parti lar design point—usually rated load. The Clark system constant pressure turbocharging, however, is inhere capable of maintaining optimum efficiency not only at de point, but over an extremely broad operating range as w The reason: *Clark turbocharging provides a flexible sup of combustion air that varies in direct proportion to lo* It does not depend on pulses of exhaust gas or on eng driven blowers, hence is free to provide the exact amou of air demanded by the engine. At light loads, there neither a fall-off in performance nor any "lean out" prob arising from too much air. With increased loads, the tur charger is able to pump increasingly more dense scaveng air into the power cylinders. There is no element in



Performance curve of Clark Model TLA turbocharged, 2-cycle, gas-engine-driven compressor. Unit features 17"x19" bore and stroke. Rated speed is 300 rpm. Rated bmep is 102 psi. Note the remarkable parallel between the fuel consumption and specific air consumption curves.

For more data on advertised products, use cards, last page.

tw cycle compressor performance for ee ariable load applications

stem to impede or interfere with the performance of the rbocharger as it responds to the higher power require- nts. Thus the fuel/air ratio remains constant through the tire operating range for best engine performance.

Q. Are there other important advantages of the Clark Constant Pressure Turbocharging system?

A. Yes. In addition to efficient combustion, the large mounts of available scavenging air have a cooling effect on e cylinder walls, cylinder heads and piston heads. Possi- lity of detonation is minimized, better lubrication is as- ured, and the temperatures of the exhaust gases are con- olled as they enter the turbocharger. The cooling effect of e excess scavenging air is especially advantageous at high mbient temperatures. It lowers overall cooling duty and ables the Clark intercoolers to provide adequate scaveng- g air cooling. There is no need to resort to evaporative oling of air or other special means of preventing detona- on and cylinder wear.

Q. How does Clark achieve such good low speed lug- ing characteristics?

A. With Clark turbocharged, two cycle engines, compressor pacity can be most easily and efficiently varied by ad- sting speed while maintaining at or near rated load torque. *The engine-driven compressor is then operating at rated ad all the time, at which condition it functions most effi- ently.* The exceptional low speed lugging characteristics due primarily to frequent power impulses that reduce clic speed variation. At low speeds, cyclic speed variation always accentuated because flywheel inertia is reduced proportion to the square of speed reduction, and power pulses become less frequent with respect to time. Thus two cycle engine has a great advantage because each linder fires every revolution.

Q. How do Clark two-cycle engines perform under erload conditions?

A. A glance at the chart showing actual test data taken from Clark turbocharged Model TLA gas-engine-driven com- ssor demonstrates graphically that the fuel consumption rve is remarkably flat over a wide range. When operating high as 20% overload under emergency conditions, Clark gines actually burn *less* fuel per bhp than at rated load. en more important is the manner in which the specific air specific fuel consumption curves parallel each other fectly over the entire range. This illustrates the inherent vantage of Clark "true" turbocharging system. Once the gine is started and the turbine is self-sustaining, the turbo- rger adjusts itself freely and almost instantaneously to demands of the engine.

Q. How does ignition timing control improve operat- ing performance?

A. There are two conditions in which ignition timing control is used with the Clark system: At startup and at reduced speeds. During the starting cycle, the timing control automatically adjusts the ignition to increase the flow of heat to the turbocharger. This shortens startup time and substantially reduces consumption of starting air.

At reduced speeds (i.e. from 50% to 80% rated speed), the ignition is automatically regulated to maintain optimum ignition timing consistent with the rate of pressure rise in the cylinder with respect to time. Thus the peak pressure is reached at or near top dead center and expansion of the burned gases takes place most effectively with less tendency to detonation.

Q. What is the net effect of combining turbocharging with two-cycle engines?

A. The user enjoys all the advantages of a two-cycle engine —simplicity, fewer moving parts, greater dependability— plus the advantage of turbocharging—more power in less space, better fuel economy, greater operating flexibility. Clark two-cycle gas-engine-driven compressors are very conservatively rated. Lower bmep eliminates the ignition difficulties and fouling tendencies common in higher rated machines. There are no large exhaust or intake valves to warp, pit or burn. Two-cycle design keeps continuous downward pressure on the power pistons, thereby eliminating oil "pumping." There is no piston ring blowby, the cause of sludging and crankcase oil dilution. The two-cycle engine is less sensitive to detonation under high ambient temperatures. Thus Clark design reduces costly maintenance and assures more profitable "uptime."

Q. In what type of application is Clark capacity varia- tion with speed useful?

A. Pipeline gas transmission where there are few units in a station. Process applications employing gas engine drivers. Gas distribution boosters where the compressors are located near sales outlets. Manufactured gas compressors. Field gathering compressors where few units can be economically employed and wide variation in gas supply is expected.

For more details on how Clark variable-speed, variable-load performance can help you, contact your nearest Clark office or write to:

CLARK BROS. CO., OLEAN, N. Y.

FOUR-LETTER "INSURANCE POLICY"

RECOGNIZED AND RESPECTED BY ALL PIPE LINE MEN

Where can you buy an insurance policy that offers more in protection than the Gaso name on a pipe line pump?

The completeness of the Gaso line insures a type and size precisely suited to your conditions. Gaso's 46-year performance record insures extra years of low-cost trouble-free service. And Gaso policy insures immediate parts for every standard model ever made, even those still operating after a quarter century or more of severe service.

It is the assurance of complete satisfaction and the certainty of an extra return on the pump investment that explain why Gasos are specified as standard equipment in the lines of so many leading operators.

GASO PUMPS
for every oil industry need

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FIRST & LANSING STS., TULSA, OKLA.
Export Office: 2612 Empire State Bldg.
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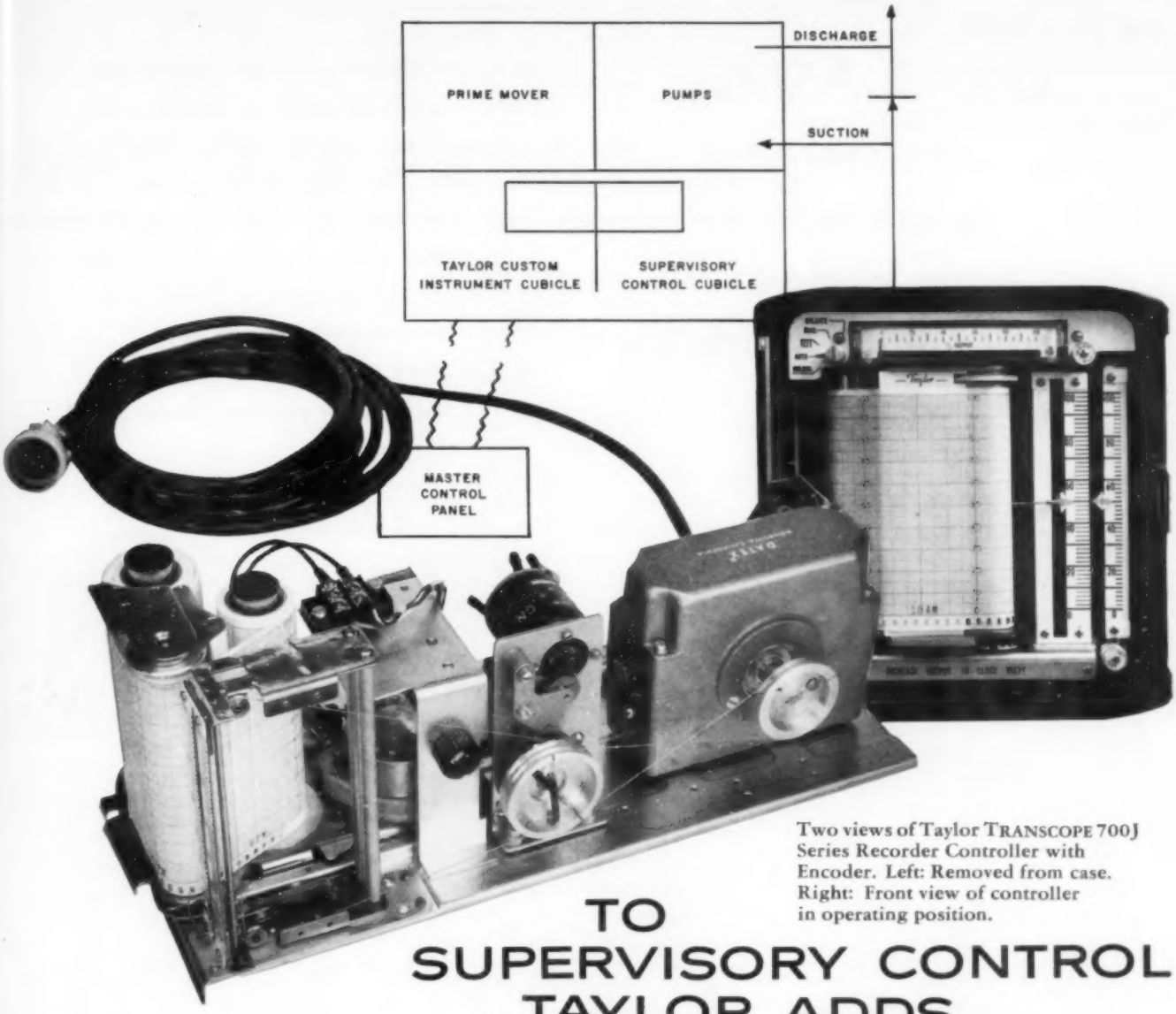

Two views of Taylor TRANSCOPE 700J Series Recorder Controller with Encoder. Left: Removed from case. Right: Front view of controller in operating position.

TO SUPERVISORY CONTROL ...TAYLOR ADDS SIMPLICITY!

Taylor local pump station control systems are designed for simplicity . . . and economy. One good example is the TRANSCOPE* 700J Series Recorder Controller with Encoder. The exclusive servo power feature not only assures more accurate records, but also permits integrally mounted encoders. This eliminates expensive high-speed analog-to-digital converters. Because each signal is individually transmitted, the source and location of any malfunction can be readily identified.

Another benefit of the Taylor system is the smooth over-ride its standard exclusive diode circuitry provides during transitions between suction and discharge control. The "reset windup" problem is eliminated.

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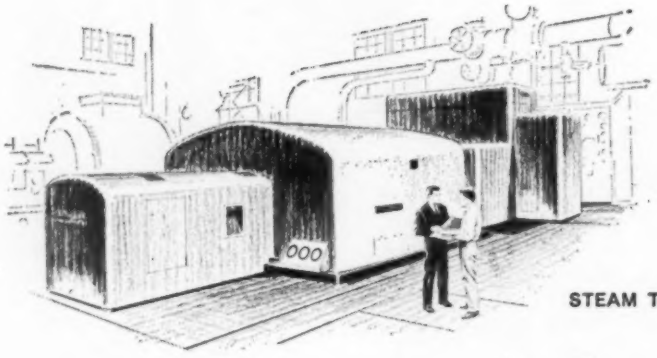
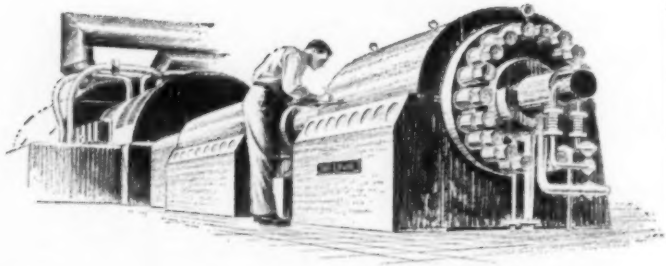
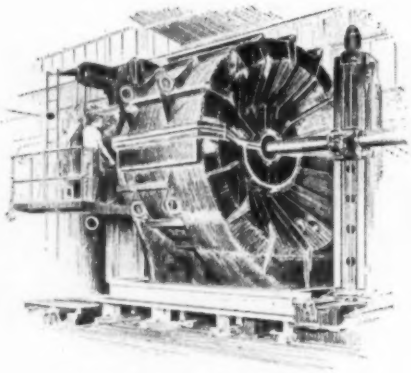


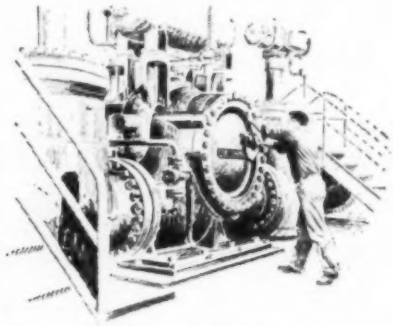
STEAM TURBINES



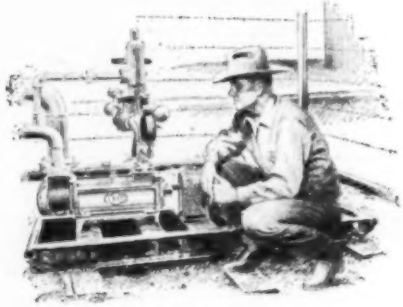
CENTRIFUGAL PUMPS



BLAST FURNACE BLOWERS



SINGLE- AND MULTI-STAGE COMPRESSORS



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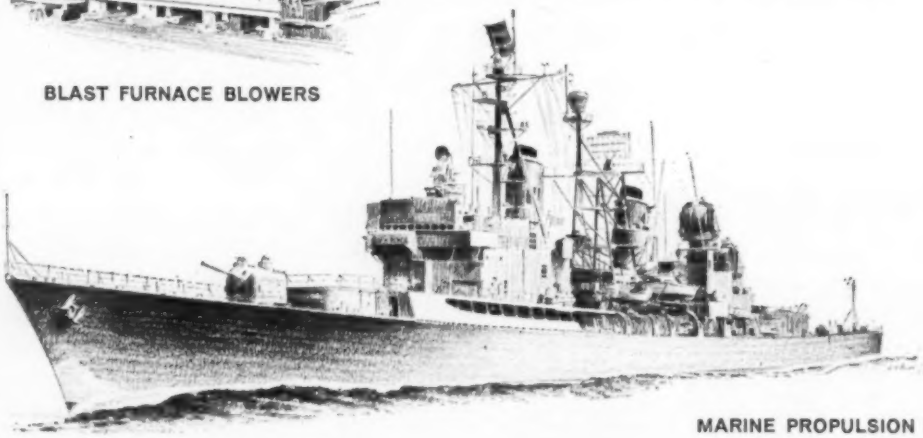

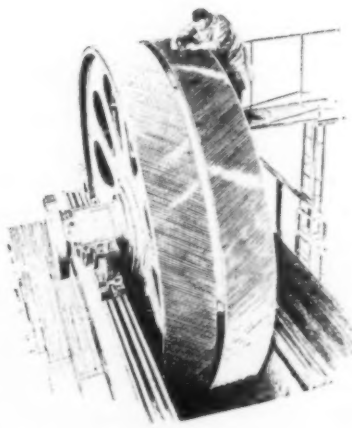

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PIPE LINE PANORAMA

Transmission Line Construction Outlays Set Record . . . Federal Power Commission reports it authorized construction of record $852.2 million in new interstate gas transmission facilities during fiscal year ended June 30. Facilities include about 6,000 miles of pipe line and 337,000 horsepower in compressor capacity. Previous high was $846.7 million authorized during fiscal 1960.

Since February 1942, when present certificate provisions of Natural Gas Act became effective, FPC has authorized construction of more than 100,000 miles of pipe line, about 6.8 million horsepower in compressor units and other facilities, totaling more than $8.9 billion.

Subsurface Natural Gas Storage Moves Ahead . . . Ways to store large amounts of natural gas near metropolitan areas, where storage fields are not available, are well along in development stage.

One of the most promising is storage of liquefied natural gas at atmospheric pressure in a subsurface prestressed concrete structure covered with insulated roof. Installation cost is estimated at $0.80 to $1.50 per Mcf of tank capacity, depending on existing ground water level. In comparison, above ground storage tanks range from $2.85 to $3.43 per Mcf of capacity.

Subsurface evaporation rate is comparable to above-ground tanks. Also, preliminary tests on model concrete vessels containing liquefied nitrogen surrounded by water-saturated sand have indicated that pressures exerted are encouraging. Field testing is expected to begin this fall.

Demand for Canadian Gas Shoots Upward . . . Forecasts are that Canadian gas demand will reach 2.2 billion cubic feet daily in 1962, nearly double 1.2 billion average in 1960.

Prospects for additional exports to U.S. markets is spurring pipe line construction. Biggest project is 1,500-mile line from Whitecourt, Alberta to San Francisco, including 1,240 miles of 36-inch line—the world's longest stretch of this diameter pipe. To be completed November 1, the $315 million line is expected to make initial deliveries of about 585 million cubic feet of gas daily, with capacity of 1.2 million cubic feet daily. Other projects include Alberta Gas Trunkline's Foothills line, and Western Pacific Pipe Line's 505-mile, 12-inch crude oil line from Fort St. John in northern British Columbia to Kamloops.

New Data Transmission System for Pipe Lines . . . On display at annual instrument-automation conference in Los Angeles last month was a new, low cost, digital data transmission system for remote display and recording of information from various types of pipe line meters.

System is self-synchronizing and self-checking, with data transmitted as a six-character decimal digit message. System records in one central location flow data from a number of points along gas, oil and water lines.

Pipe Line Briefs . . . Naming of Vermont's Public Service Board Chairman Charles R. Ross to Federal Power Commission brings five-man agency to full strength for first time in several months; however, look for Jerome Kuykendall's resignation to drop complement to four shortly . . . **Shortage of pipe line welders in recent weeks** has resulted in no widespread demand for bonuses or extra hours, and hopes are there will be none . . . **In mid-August, natural gas common stocks hit all-time peak of $60.72,** up 32 percent in 18 months . . . **Here is outlook for natural gas industry** as seen by outgoing president of Independent Natural Gas Association of America, W. E. Mueller: U.S. demand for natural gas will jump nearly 75 percent in 10 years, from 13 trillion cubic feet annually in 1960 to 18.5 trillion in 1970. This will mean $23 billion additional investment by pipe line and distribution companies.

Canada – Cali

By Melvin A. Judah, Editor
and Donald G. DePugh,
Construction Editor
PIPE LINE INDUSTRY

MUCH HAS ALREADY been said about the great gas pipe line system that is linking extensive Alberta gas reserves with the ever growing gas demands of Northern California and the Pacific Northwest. But even after traveling the length of the system from the San Francisco Bay area north to Alberta it is not easy to comprehend the tremendous job done by the contractors, managers, and engineers who are completing this $300 million giant.

Work on the line is now nearing completion after four years of well planned engineering and design including a year's actual field construction; construction is also well along on the four compressor stations and the communications and control system which will direct them.

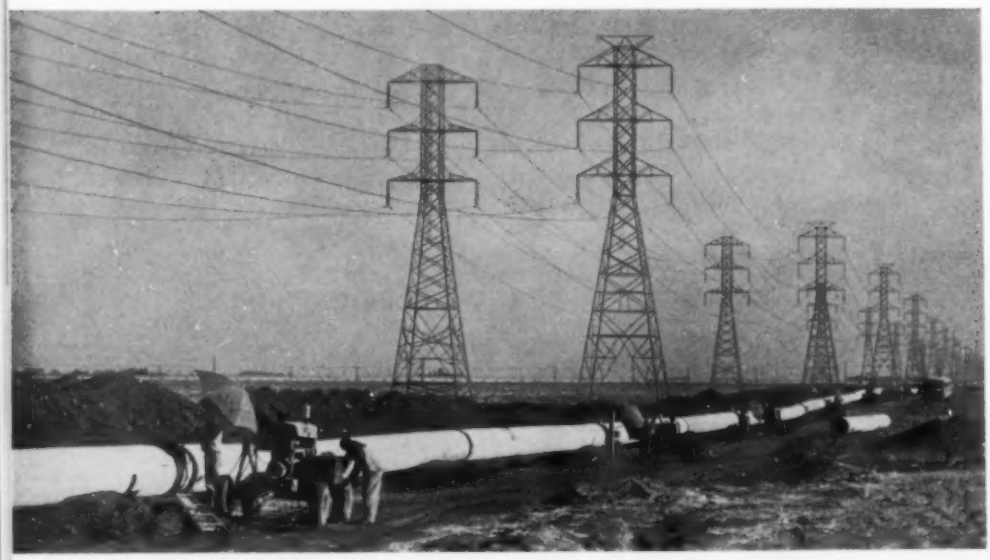
Here are a few of the facts about this project that rate it tops:

- Its 1,240 miles of 36-inch XL x-52 main line is by far the greatest length of this big pipe laid in one project and virtually all of this has been put into the ground in less than a year. In addition, there are 126 miles of 30-inch main line in the Alberta Gas Trunk Line Co., Ltd., section plus 203 miles of laterals to processing plants or delivery points.

- More than 914 miles of the 36-inch main line between a point about 99 miles north of the Antioch, California terminus and the British Columbia-Alberta border were internally coated with a 2½ mil (minimum) epoxy resin coating system at railhead and mill plants. This was the first time that a complete gas main line of this size had been internally coated.

- Almost one-half of the main line pipe welds were made in double jointing field plants prior to stringing. The asphalt coat and wrap, or asphalt mastic corrosion protection system was applied at these plants except for the Alberta section. There coating and wrapping was done over the ditch. Welding and pipe handling techniques perfected by contractors at these yards,

From the north side of the Elk River near Elko, B.C., the line drops down a cliff nearly 1,000 feet. Crossing is 300-feet wide and the rock river bottom had to be blasted and backhoed by contractor Price-Poole to make ditch.



The firing line of 26 welders here made over two miles per day on H. C. Price's spread south of Red Bluff, Calif. as construction moves toward completion. In this Sacramento Valley spread where temperatures reached 115° F, earth mounds, placed every 80 feet, provided excellent support for the heavy coated pipe in the hot sun. Mounds were made by front-end loader which scooped up dirt right alongside ditch. PG&E also had to cross several irrigation canals littered through the valley.

California Line Sets Construction Marks

and the first field tests of a new on-the-line automatic oscillating-head welder marked important pipe line advances.

• Field construction activity by both Canadian and U.S. contractors virtually eliminated any winter shutdown. The skill of these pipeliners and the ingenuity of their equipment suppliers stretched the season to 12 months; river crossings, timber clearing, grading, and corduroy road building in the muskeg country continued through the winter. Thorough advance planning plus excellent coordination between project companies and their engineer-managers was a major reason for the success of the project.

Dual 26-inch lines were laid across the Sacramento River, Sherman Island, and the San Joaquin River—a stretch of 5 miles—by Hood Construction. Dredging progresses across 3,000 foot Sacramento where 95,000 square yards of dirt were excavated. Lines were laid in 25-foot wide ditch, 7½ feet apart. With Asphalt-mastic and concrete coating 40-foot joints weighed over 8 tons.

NEW CONSTRUCTION IDEAS

On a pipe line job that puts about a half million tons of steel in the ground at a record pace you expect to see pipe line contractors and engineers coming up with top time and money-savers; and there were important new ideas on every section and spread. Here are some of the ones we ran across on the tour of the line.

Preliminary Rock Survey. In asking for bids, both PG&E and PGT provided each bidder with rock survey reports; there were no contract provisions to make premium payments for rock excavation. The rock survey was performed by a two-man party equipped with a gasoline driven portable drill mounted on a power wagon. Seven-eighths inch cores were taken at approximately 2,000-foot intervals and where pronounced terrain changes occurred. Correlation between the preliminary survey and trenching experience was good.

A 100-foot wide right of way strip was obtained, as a general practice, to provide width for handling the big pipe joints and to provide room for future looping. It has proven to be very satisfactory during construction particularly in rugged terrain.

New On-the-Line Automatic Welder. For the first time on actual field construction, H. C. Price Co. used the line-traveling automatic welder developed by Price with Crose-Perrault Equipment Corp. and Hobart Brothers Co. This machine makes use of an oscillating welding head with the arc shielded by carbon dioxide. It was used for filler and cap passes over manual stringer and hot passes. Passes are made from 12 o'clock to 6 o'clock down each side of the pipe. All welds were radiographed; some were cut out and given complete physical tests. PG&E engineers reported no unsatisfactory welds by this machine in four weeks of development usage.

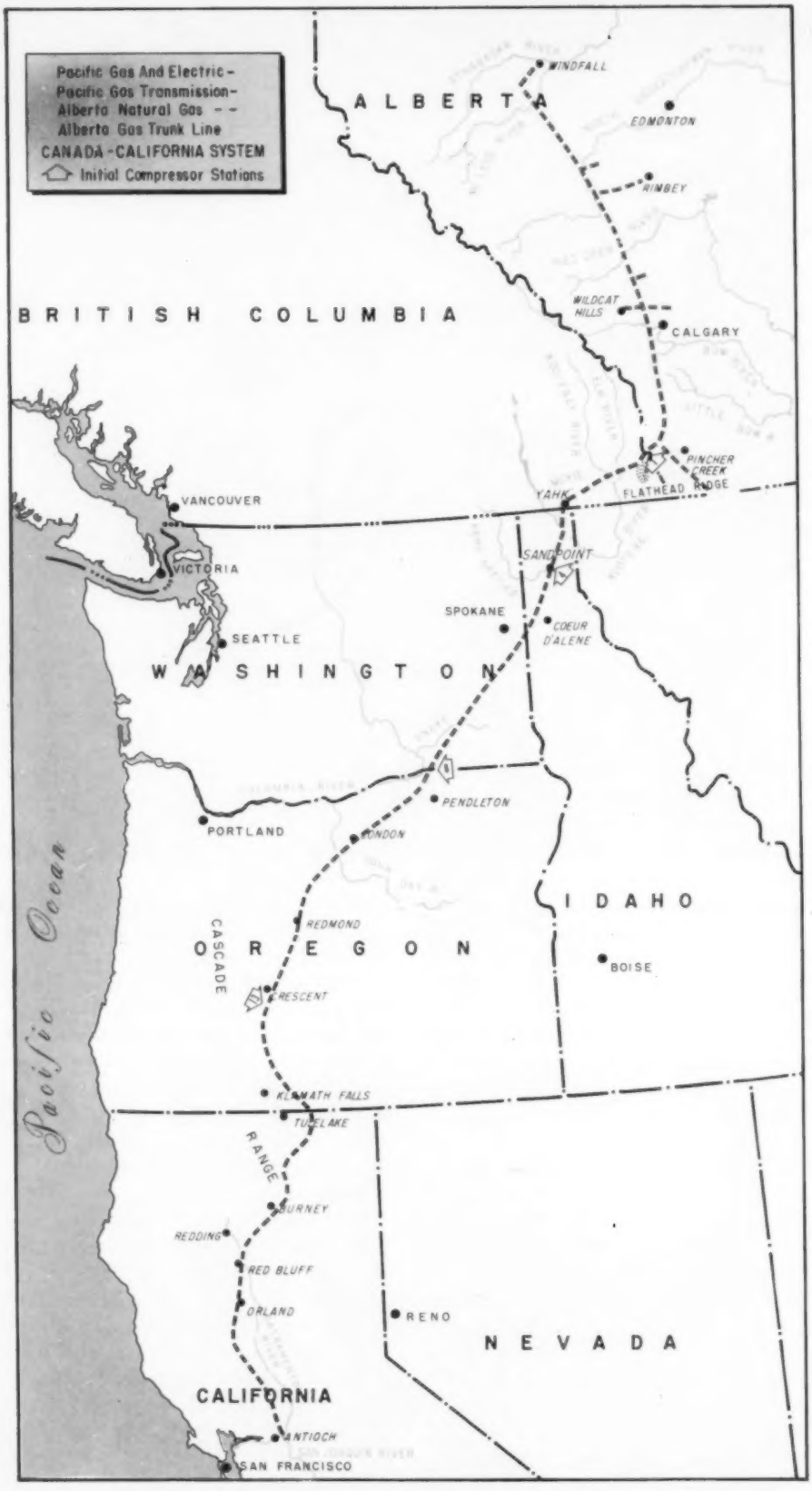
Earth Pads Support Double Joints. To give proper support to the heavy 80-foot joints of coated pipe during hot weather construction in the Sacramento valley, Ray Wetter, PG&E's project superintendent came up with both a skid and coating saver. Mounds of earth were thrown up by a front end loader approximately every 80 feet. Much of the cultivated land here was rich irrigated soil and the soft earth protected the coating. Temperatures reached as high as 115 degrees.

About 40 miles north of California's olive capital, Corning, the line cuts through rock country where pipe liners had to provide 4 inches of padding under the pipe and 8 inches around and over it in the ditch. There were some 135 miles of rock in the California section alone.

Rock Ditching and Lava. Where possible on the PG&E work Price spreads ripped all of the ditch ahead of the ditching machine. After much blasting experience a technique evolved which produced good ditch and facilitated rock removal. Twin and quad-drills mounted on sidebooms drilled holes on 36-inch intervals just inside the 48-inch trench line on each side. Holes were loaded with three sticks of 40 percent dynamite, TNT salvage flake was added and earth was tamped in for cover.

Individual fuses, 10 feet long extended from each hole. Two men, one on each side of the trench, moved down the line "smartly," lighting the fuses as rapidly as possible. Length of ditch cut with one set of charges was normally 500 feet and with the fuses burning at a rate of one foot a minute, fuse men have about 10 minutes to light the fuses and find cover.

There were more than 100 miles of lava terrain in Northern California and also some volcanic soil on the PGT section. The delayed blasting technique just described gave the best results in ditching lava; in several instances war surplus Composition B was used in the lava because its burning rate of 19,000 feet per second did



Route of giant Canada to California system. Construction consisted of 1,240 miles of 36-inch pipe plus 126 miles of 30-inch main line and 203 miles of laterals from processing plants and to delivery points.

a better job than the somewhat faster TNT. In lava this method gave a minimum width ditch with clean walls despite its porosity.

Padding From Spoil—'A Shaky Lizard.' One of the most ingenious and effective ways to protect coated pipe in the ditch was seen on Abe Reutzel's Price spread in Idaho. His rubber tired lizard that rides on the pipe line isn't new, it was used on Transwestern Pipeline Company work in Arizona last year, but this time the lizard has the "shakes." A small gasoline motor spinning an eccentric weight has been added. When the motor is running and spoil (even fairly rocky) is dumped on the lizard the vibration and long rod spines extending back into the backfill above the pipe do a very effective job of putting fine soil around the pipe and keeping rocks farther up in the fill.

Despite the rugged country crossed by the Canada-to-California line and its size it was "put to bed" as softly as any line we've ever seen. A fine grade of earth was used for ditch padding and shading in all sorts of rock country. Very often this was moved in with bottom loading earthmovers and then placed in the ditch with front end loaders. On several of the spreads the small "kitten" tractor with a 42-inch dozer blade was used to crumb the ditch bottom; we observed them on Western Pipe Line, Inc.—J. P. Neill & Co. joint venture in northern Oregon wheat country and on Price's spread two. Western-Neill also made good use of a modified wheel ditcher for padding. Spoil was picked up by the wheel and dumped onto a steel grate which allowed the fines to drop on the conveyor for shading; the larger rocks fell back clear of the wheel and conveyor. A similar method was used by Majestic Contractors on the Alberta Gas Trunk work in Canada where the modified ditching machine dug a "waste" ditch alongside the pipe line ditch to provide shading material.

Disking Straw on ROW Holds Sand. Even clean-up brought some unusual problems, in addition to the normal ones of keeping the landowner happy. For several miles in the vicinity of the Washington-Oregon state line, loose sandy soil was a problem; especially one of keeping it in place against winds when it was dry and without cover. To solve this Western-Neill made good use of some of the straw left from the wheat harvest in this rolling grain belt region. Straw was disked into the loose sand and in effect "reinforced" it.

It was power dry when spreads were working in the wheat country

sections or Washington and Oregon and dust was a problem. Stringing trucks were pulled by tractors along the ROW reducing dust blow. Western Supt. John Wells' helicopter was a lot more practical way to get up and down the line than was a small car. Western's record of 86 miles of 36-inch pipe laid in 24 working days didn't settle the dust either.

Coal Fire for Ditching. Most of the winter work in Canada involved clearing, grading, corduroy road building with rip-rap and pipe stringing. However some pipe was laid and in one stretch of Alberta Consolidated Pipe Line Builders Schedule 2 while it was still plenty cold. Mannix Superintendent Odis Hare made good use of coal to get this section of gas line ready. Some 80 tons of coal were spread over the ditch line and burned to thaw a section of the ground for ditching operations.

Railhead Plants. Virtually all of the 36-inch pipe laid between Antioch and the Alberta border was double jointed, yard coated, and except for the southernmost 99 miles internally coated with epoxy at railhead or mill plants. Many benefits of these practices were mentioned by PG&E, Bechtel and several contractors:

- Plants provide better welds under a wider range of weather and field conditions. Pipe handling on the ROW is reduced, and even if plant set-up costs made each double-joint weld cost the same as a field weld, the faster footage with minimum field operations in stringing, line-up and welding would provide worthwhile savings.
- Controlled coating conditions plus strict inspection produced a top quality external coating job at the railhead plants. Reduction of dope handling to only that needed for field joints and minor repairs reduced fire hazards in the timber country.
- PG&E engineers estimated that internal coating might well reduce the friction factor from 0.0023 to 0.00205 in the modified Weymouth flow equation at a design rate of 800 MMcf/day. This would mean a reduction of 28,000 compressor horsepower representing a capital savings of almost $7 million for a construction outlay of about $1.5 million. In addition, PG&E Manager of Gas Construction M. H. (Hap) Chandler cited detection of some internal defects which might otherwise have gone unnoticed prior to construction; as well as more effective cleaning and purging of the line after construction and hydrostatic testing.

There was a number of different approaches in the contracting of double jointing and internal-external coating application. H. C. Price Co. double jointed and coated much of the line on the California section at a yard in Burney, California early in the year. At Napa, California Price applied asphalt mastic coating to pipe double jointed at a plant set up by Kaiser Steel Corp. near its mill; L. C. Russell Co., Inc. applied internal epoxy coating at the Napa plant.

Pipe for the Washington-Oregon section was double-jointed, and coated with the asphalt-wrap system and internal epoxy application by two highly automated plants designed and operated by Stanley-Bledsoe Corp. As in the other field plants, Stanley-Bledsoe's used the submerged-arc, automatic push-button control of pipe rotation and arc control. Stanley-Bledsoe designed these yards for a bare minimum of pipe handling. A total of 85 men moved the pipe through double-jointing (two external welding heads and one internal), the grit blasting and spraying internal coating operation and then the external protection system without lifting pipe off the 1,000 foot rail system.

Pipe was brought to the racks by fork lift trucks; after double jointing was completed by the three passes pipe rolled to a grit blaster where it was cleaned to gray metal prior to spraying on the epoxy. A preheat was used in winter operation to defrost the double joints.

The Napa plant operated by Kaiser used a somewhat different welding technique from the normal automatic double jointing practice. Two passes were used instead of three, first the inside and then the outside pass. In running the outside pass Kaiser used a method of flux handling adapted from mill welding. The external weld bead rolls in granulated flux held on the pipe by a grooved rubber belt held in position by rollers.

Another Price yard double-jointed and coated pipe in Idaho; Price-Poole double-jointed and coated pipe for the Alberta Natural Gas section. Dutton-Williams Brothers Ltd. and Banister Construction Co., Ltd. operated double-jointing plants at several locations in Alberta. No internal coating was applied on the Alberta Gas Trunk Line; pipe was coated over the ditch with an asphalt-fiber glass, felt wrap system.

Winter Pipelining. Contractors, especially the Canadian pipeliners, made good use of winter conditions for as much work as could possibly be done; timber clearing, grading, road building, and river crossing work continued through the winter to take advantage of ground support for equipment and minimum fire hazard conditions, generally. West Central Alberta is rugged country with few access roads and plenty of muskeg swamps. On Schedule IV of Dutton-Williams Brothers, Ltd., stringing was completed on the 30-inch main line

Generally "Ice Bridges" are built by mother nautre, but Majestic Contractors built up an ice bridge on the North Saskatchewan River in Alberta by flooding and freezing a layer of ice 18 inches thicker than normal, while making the crossing in winter. Bridge supported the drilling and construction equipment.

Sherman Island was one big peat bog, PG&E Inspector John Nelson reported. A platform, made of four 12 by 12s, under the 35-ton crane outriggers, gives it support during line-up.

A picture is worth a thousand words, especially this one. Here's a good example of conditions met by Dunn Brothers whose truck seems to be "floating" through the dust while stringing

and part of the Windfall lateral before the spring thaw brought road bans.

To get through muskeg swamps contractors made good use of the timber slashed in clearing ROW for riprapping; when covered with earth fill and gravel it made a good road for the following construction crews and future pipe line access.

On Schedule III, Majestic Contractors, Limited had about the same kind of pipelining country as that to the north. Majestic completed clearing, grading and all river work prior to the spring thaw. Alberta Consolidated Pipe Line Builders also completed as much work as possible during the winter months on Schedule II. A hang-over winter slowed early spring work on this section as well as on some of the other Cana-

One of the hazards in early construction work was rain and the mud resulting from snow thawing. Here on Western-Neill's spread, special rubber tired cradles were used for lowering-in the 36-inch pipe near Oregon-California border.

80-foot joints on PG&E spread. Right of way often had to be watered down to keep the dust to a minimum and prevent interference with welding operations.

A 2 by 4 stub holds steel in tension, and keeps pipe ends from getting out of round. Asphalt-mastic and concrete weight coating gave river crossing pipe negative buoyancy of 10 percent.

dian work. Ditching started on April 18th and was stopped twice before weather favorable for field work came very late in April. The Calgary area had a snowfall of 12 inches on the 19th of April.

In several areas of British Columbia, Idaho, and the Pacific Northwest crews were severely hampered by snow, rain and the resulting muddy right of way for several weeks early in the spring. But once it dried out they made up for the delay with a record pace.

River Crossings. Run-off from the Rocky Mountain right of way makes most of the rivers crossed by the Alberta-California pipe line fast, deep and wide. In addition, high banks cut by many of them make the approaches a tough construction problem; especially where railroads parallel a river.

Work on crossings of those rivers flowing eastward form the Alberta foothills was completed during the winter to get a jump ahead of the spring runoff. All of the Canadian crossings are buried.

Dutton-Williams completed the crossing of the McLeod River in Schedule IV work during the winter. On Schedule III, Majestic carried out drilling operations for blasting the bottom of the North Saskatchewan from an "ice bridge" build up by pumping water on top of the river ice and allowing it to freeze thicker each night. This built a layer of ice over two-feet thick which would support the weight of drilling equipment and machinery. Other major crossings in Alberta included the Bow River and the Red Deer crossed by Alberta Consolidated Pipe Line Builders northwest of Calgary and the Oldman River and Crowsnest Creek crossing of Majestic on Schedule I.

Pipe was internally coated, double jointed and externally coated at field plants. Lift truck has wide bearing surface fork to protect soft-coated pipe in transporting it.

Price-Poole is completing the crossing of the Elk River in British Columbia after a fast run-off of high water caught operations in the spring. A steep, rocky canyon gives the line a drop of almost a thousand feet down the Elk's north bank; from here eastward the line winds along Wigwam River before topping out across Flathead Ridge at over 7,000 feet elevation. In British Columbia, single 36-inch line crossings were laid under the Moyie at three points and the Kootenay once. Taking a route that generally follows the valley through this beautiful and rugged mountain country the line dipped under the Moyie at eight more points across the border in Idaho; in fact, it crosses the winding Moyie eight times within an eight mile section.

At Sandpoint, Idaho, the PGT line crosses the 2,200 Pend Oreille beneath 70 feet of water. This crossing and the Kootenai in Idaho were pulled by River Construction Corp. early in the year.

Fish Research on the Snake. Missouri Valley Dredging Company laid this 1,024-foot single 36-inch crossing. A railroad line on each side of the Snake at Starbuck, Wash., complicated blasting practices in addition to strict shooting restrictions because of fish runs. Two Washington state agencies had inspectors on hand during excavation of the river bottom. The Department of Fisheries was checking on any possible danger to salmon headed up the river and the Department of Game was concerned with steelheads.

To find out just what hazards there might be to fish, Pacific Gas Transmission sponsored research by the Dean of the College of Fisheries of the University of Washington to learn when fish run and when they might be sleeping. There were a number of interesting results of this research. Fish apparently were most likely to sleep in certain sections at some hours; luckily, these areas were some distance upstream and downstream from the crossing location. After PGT found out a great deal about the travel habits of steelhead and salmon, permission was received to blast at night through July. The night blasting gave Missouri Valley Supt. W. H. "Red" McCullough and Engineer Louis Jackson some headaches in making sure that all roads and the railroad were clear of traffic. But the ditch was blasted with no injuries to people —and no dead fish were found.

Other river crossings and canyons gave contractors tough going on the PGT section. Western-Neill had some sharp drops into the Latah Creek valley, at Rock Creek and at the Spokane River crossing. Juniper Canyon in Oregon with its 600-foot sheer wall on the south side, and the steep banks of the John Day Canyon were just about straight up-and-down pipelining for Western-Neill.

In California, the line takes an overhead route, crossing Lake Britton on an abandoned highway bridge. H. C. Price completed three unsupported but cantilever anchored spans across deep cut canyons north of Red Bluff in addition to one underwater crossing of the Fall River and a crossing of the Sacramento River near Red Bluff.

Hood Corporation is completing twin 26-inch, asphalt mastic and concrete coated pipe lines across the 3,000 foot Sacramento, a 3½-mile section across Sherman Island and another nearly 4,000 foot dual underwater crossing of the San Joaquin just before the line comes into the Antioch meter station and terminus. Much of the Sherman Island stretch was river fill or peat which made for "marsh pipelining" whether wet or dry.

'Who's Who' on the PG&E-Canadian Project

Pacific Gas and Electric Company —PG&E, in addition to sponsoring the entire project is engineering and managing construction of the 296 miles of 36-inch in California which it will own and operate.

Pacific Gas Transmission Company (owned 50 percent by PG&E, 9 percent—Canadian Bechtel Limited, 7 percent—Blyth and Company, 7 percent—International Utilities, 2 percent—Montana Power Company, and 25 percent by public). PGT will own and operate the 612 miles of 36-inch main line from the Canadian border near Kingsgate through Idaho, Washington, and Oregon to the California state line.

Alberta Natural Gas Company (owned one-third by Pacific Gas Transmission Company, one-third by Westcoast Transmission Company, Limited, and one-third by the public) is incorporated and authorized by an act of the Parliament of Canada; ANG will receive gas from The Alberta Gas Trunk Line Company, Ltd. and act as a contract carrier for Alberta and Southern and Westcoast through 107 miles of 36-inch line in British Columbia.

The Alberta Gas Trunk Line Company Limited, has no corporate connection with any of the other participants. AGTL has been incorporated by the legislative assembly of Alberta to transport gas declared surplus to Alberta requirements for gas exporters. It will own and operate the pipe line facilities extending from near Windfall, northwest of Edmonton, to Crowsnest Pass at the B.C.-Alberta border. AGTL will own and operate 223 miles of 36-inch, 126 miles of 30-inch, 81 miles of 22-inch, 86 miles of 16-inch and 12 miles of 12-inch main line and laterals connecting with the system.

The Alberta and Southern Gas Company, Limited, is a wholly owned subsidiary of PG&E. Its principal function is the purchase of gas from producers in Alberta and to arrange transportation to the international boundary. Alberta and Southern holds permits to export gas from the Province of Alberta and from the Dominion of Canada.

Bechtel Corporation is furnishing the engineering-management services for the portion of the pipe line system from the U.S.-Canadian boundary to the Oregon-California state line. Canadian Bechtel Limited has the same responsibilities for the portion of the system in Canada.

Also associated with the project are **Westcoast Transmission Company Limited, El Paso Natural Gas Company,** and **Canadian-Montana Pipe Line Company.**

At Battle Creek crossing in Northern California, 0.625-inch w.t. pipe was used for the 138-foot span. Pipe is 28 feet above expected high water; vertical support was used only until after hydrostatic testing.

Western-Neill joint venture had 504 miles on the PGT section and John Wells, spread superintendent of Western Pipe Line used helicopter to good advantage to keep up with progress in Washington and Oregon.

Line Design. Pipe of a minimum wall thickness of 0.438-inch was selected for the 36-inch line giving the API 5LX x52 tube a maximum operating pressure of 911 psi in Class 1 code locations. Heavier wall pipe was used for sections down-stream from compressor stations (0.656-inch), river crossings (0.531-inch) and populated areas, road crossings, etc. (0-453-inch, 0.469-inch, 0.500-inch, 0.563-inch up to 0.6875-inch near the Antioch terminus). All design engineering meets or "betters" the ASA Code B 31.1-1958 for Gas Transmission and Distribution Piping systems.

Testing. The entire Alberta-to-California system will be tested hydrostatically except for several short, and steep, sections in British Columbia which will be air-tested. To provide for elevation changes, the minimum hydrostatic test pressure at peak elevations will be 81 percent of the specified minimum yield strength; maximum pressure applied will equal the specified minimum yield strength of the pipe. Filling the line with water in certain mountainous areas in itself was a good engineering problem; a number of cuts had to be made for testing to stay within pressure limits. PG&E is doing the pressure testing on the California sections with equipment and engineering service provided by Williams Pressure Service. On the PGT section, Thomas Contracting Company is carrying out the pressure tests; Mannix Co. Ltd. is putting on the pressure "squeeze" for the Canadian portions of the system.

Valves. Full opening, through-conduit valves are being installed throughout the system; valve spacing is at intervals of 15 to 20 miles at accessible points. Pig trap assemblies will facilitate on-stream pigging on sections of line north of the Oregon-Washington border. There are no drip installations on the entire pipe line system.

On block valve assemblies the blowdown stack has been piped about 100 feet away from the valve. Both sides of the pipe line are connected to the blowdown, a bypass permits operation of the main line valves under maximum pressure differentials.

For valve operators at several locations PG&E specified a specially designed electric motor with 12-24 volt rating, which may be energized from an auto or truck electrical system. A ball-end-screw gear assembly on large valves will reduce friction and the force necessary for opening and closing of the big main line valves.

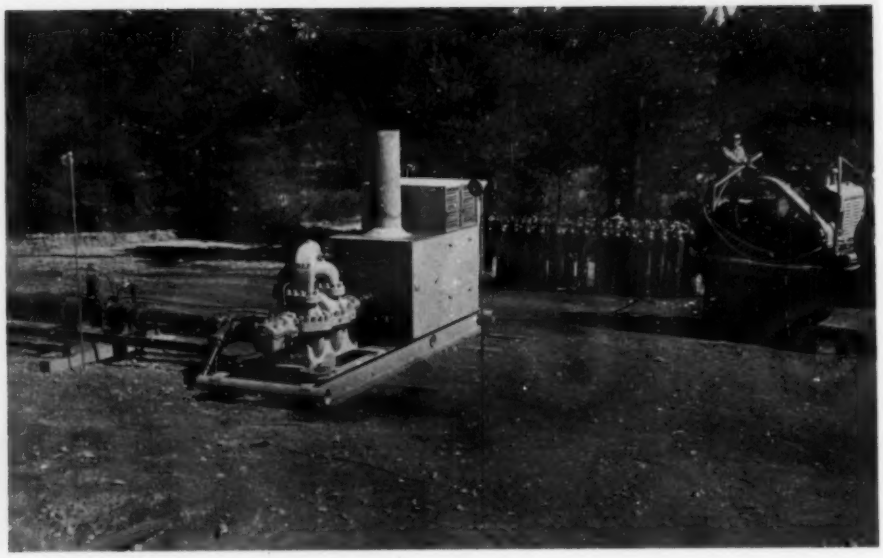
Corrosion Protection. On the Pacific Gas Transmission and Alberta Natural sections the coating systems consist of asphalt enamel, glass fiber and 15-pound outer felt wrap totaling approximately $\frac{3}{16}$ inch. A double coat system of these basic materials was used in corrosive "hot spots." In California, the contract bid for a $\frac{5}{8}$-inch asphalt mastic system represented only a "slight additional" cost, PG&E engineers reported, so this protection was applied on the entire 296 miles. An asphalt enamel, glass fiber and wrap system was applied over the ditch in Alberta work. Major river crossings, including the Kootenai, the Pend Oreille, Snake, Sacramento and San Joaquin, plus several smaller ones were protected with the asphalt mastic system plus reinforced concrete to provide a negative buoyancy of 10 percent.

Cathodic protection leads have been installed at regular intervals throughout, the line and protection will be applied following current requirement surveys after construction.

Compressor Stations. Design of the Canada-California system has been set to handle the initial export authorization granted by the National Energy Board of up to 458.75 MMcf a day; Westcoast has authority to export to El Paso Natural Gas up to 152 MMcf a day through the PGT system and approximately 36 million cubic feet a day will go to Canadian-Montana Pipe Line Company through an Alberta lateral. For over-all design, future delivery of up to 800 MMcf per day to PG&E, plus 300 MMcf per day to El Paso Natural was used. To handle that capacity 16 stations were provided for in planning; for initial operation the system will be powered by four stations utilizing a variety of equipment.

Station 1, near Crowsnest Pass in B.C. will have four KVH-12, four-

R. E. Wetter, PG&E project superintendent, and R. E. "Bob" Ezell, spread superintendent for H. C. Price, discuss construction work near Red Bluff, Calif.



A fill pump installation at Williamson River for hydrostatic testing. Thomas Contracting Co. performed testing on the PGT system. Line was tested from 81 to 100 percent yield in mountain terrain. System was hydrostatically tested except for a few short sections in British Columbia.

cycle, gas engines moving gas with integral reciprocating compressors. It will be attended and locally operated initially but design provides for possible future remote control.

In the Idaho panhandle near Sandpoint, Station No. 4 will have a 6,000-hp two-shaft, regenerative gas turbine driving a centrifugal compressor. This station, like the two others on the PGT section will be equipped for remote and unattended operation from a Spokane control center. Station No. 8 located just north of the Washington-Oregon border will have two 5,000 hp, four cycle, LSV-16-cylinder gas engines driving centrifugal compressors through a speed increaser. Just south of Chemult in Oregon, PGT will have the southernmost initial station; here station 13 will house two 5,000-hp two-cycle TPV-12 gas engines driving centrifugal compressors through a speed gear.

Communications—Control. While not all of the stations on the Canada-California gas line will be automatic and remotely controlled initially, the system will be built with a high degree of automation and PGT stations will be remotely controlled from Spokane. A microwave system is now being built to provide a continuous link between San Francisco, Spokane and Calgary. Base repeater stations will be located on 17 mountain top sites; this is one place where the mountain terrain was a help to the pipeliners.

Vehicles of key operating personnel will be equipped with mobile radios; 96 transistorized units plus, 11 "Han-

Changes were made on Abe Reutzel's lizard used in backfilling to keep rocks off pipe. Lizard had small engine to rotate steel eccentric weight and allow fine dirt to pass through vibrating "fingers" that extend back under fill.

Small dozers were used on many spreads to smooth out bottom of ditch and spread padding under pipe. This "Kitten" is on Western-Neill spread. Specs called for 4 inches of padding under pipe and 8 inches around and over the pipe.

Missouri Valley Dredging Company found solid rock bottom in the Snake River near Starbuck, Wash. and extensive blasting was necessary.

Mannix Co. Ltd., bends double jointed and yard coated pipe near Mt. McGillivray, B.C. on a section of the ANG system. The line comes down the west side of the Continental Divide in this 107-mile section. Price-Poole constructed most of the B.C. main line.

die-Talkie" portable units will be provided. All radio equipment will operate in the 40-50 megacycle band.

Three PGT stations will be controlled from the Spokane Dispatch Center to be located in a new operating headquarters building now under construction. For control, station discharge pressure will be the parameter. The dispatcher will set and transmit to each station that discharge pressure required. Control equipment at each station will automatically start and stop units, load each compressor properly, and from that point on adjust speed to hold the ordered discharge pressure.

Essential operating data from both metering stations and compressor stations will be telemetered to the Spokane center and displayed continuously on a digital panel. System operating data will be logged out hourly on an electric typewriter. Equipment malfunctions at any location will sound an alarm and inform the dispatcher by fault lights. In the event of a loss of communications carrier, stations will hold their last valid setting in effect at the time of the failure.

Leaders on the Alberta-California Line. On any pipe line project that spans the territory and solves engineering and construction problems that this 1,400-mile giant has there would have to be many "top hands." Hard working dreamers who made this system a reality deserve the thanks of those they serve (and ours also for real fine hospitality on a 6,000-mile junket to the Northwest).

Pacific Gas and Electric Co. Norman R. Sutherland, president; E. H. Fisher, vice president in charge of gas operations; H. W. Haberkorn, vice president—general construction; M. H. (Hap) Chandler, manager of gas construction; Roscoe Smith, manager of gas system design; Ray Wetter, project superintendent; Walter Funabiki and Al C. Fantozzi, project engineers.

For Pacific Gas Transmission and Alberta Natural. Special thanks are due C. P. Smith, vice president and manager, F. W. (Peter) McChesney, project administrator, and John G. (Jack) Smith, project engineering officer; as well as PGT general superintendent Ralph Nabors and area superintendents W. L. Langston, Chester Bond, B. A. Mills, Carl Whitmire and ANG area "super" Ralph C. Dodge.

They've been building good sized

The Crowsnest Pass serves as a backdrop for station No. 1 in British Columbia near the Alberta border. Marwell Construction Co. Ltd., is building the station which will house four 3,400 horsepower gas engine reciprocating compressors. Stations are being built with a high degree of automation.

gas pipe line systems in Alberta for a number of years and the new Foothills line surely ranks Alberta Gas Trunk a major pipe line in any league. A visit to their Calgary office is "as friendly as Texas" thanks to J. C. Mahaffy, executive vice president and general manager, Eldon V. Hunt, general superintendent and John M. Ballachey, assistant general manager.

From the first proposals written on the Canada—PG&E line, the pipelining know-how of Bechtel Corporation and Canadian Bechtel took part in shaping the project. S. D. Bechtel, Jr., president, Harry F. Waste, vice president, Duane P. Smith, project manager—PGT section, Ted B. Johnson, project manager on the British Columbia work and M. P. "Mike" Boyle, project manager for the Alberta Gas Trunk construction, C. E. Barker, contracts manager, and Don Hicks, contracts engineer in Calgary were the Bechtel leaders.

To get dirt for padding, Majestic Contractors dug a second trench alongside the line. The modified trencher has a grate above conveyor bar to catch rocks and drop them back in "waste" ditch; fine earth conveyed into pipe line ditch served as padding material. Cable at lower left is communications line between measurement station at Alberta, B.C. border and station 1. It was buried in the ditch above the padding atop the pipe line.

To these and many, many more goes the credit for providing the link which will boost Alberta oil and gas industry operations while at the same time providing fuel and power for growing Northern California and the Pacific-Rocky Mountain northwest.

—**The End**

SUPPLIERS AND CONTRACTORS FOR THE CALIFORNIA-ALBERTA SYSTEM

PACIFIC GAS & ELECTRIC COMPANY SECTION

Main Line Contractor: H. C. Price Co.
River Crossing-Sacramento & San Joaquin: Hood Corporation.
Pipe Stringing: Dunn Bros.
Pipe: Consolidated Western Steel Division, U.S. Steel Corp., and Kaiser Steel Corp.
Internal Coating Contractor: L. C. Russell Co.
Internal Coating Epoxy System: Napko Corp. and Coast Paint & Lacquer Co.
External Pipe Protection: Somastic by Pipe Linings, Inc.
Valves: Grove Valve & Regulator Co. and Rockwell Mfg. Co.
Valve Operators: EIM
Fittings: Ladish
X-ray: Advance Industrial X-Ray Laboratory, Inc. and Central X-Ray Inc.
Testing: PG&E with pressure equipment and consulting by Williams Pressure Service Co.

PACIFIC GAS TRANSMISSION SECTION

Pipe: Consolidated Western Steel Division U.S. Steel Corporation.
Valves: Grove Valve & Regulator Co. and Rockwell Mfg. Co.
Enamel: American Bitamuls & Asphalt Company
Primer: Standard Oil of California, Western Operations Inc.
Glass Inner Wrap: Owens-Corning Fiberglas Corp.
Outer Wrap: Fiberboard Paper Products Corporation
Internal Coating-Epoxy System: Coast Paint and Lacquer Co. and Napko Corp.
Construction Contractors
Schedule 2—H. C. Price Company
Schedules 3, 4, 5—Western Pipe Line, Inc., J. P. Neill & Co., Inc.
Testing—Thomas Contracting Company
Double Jointing Contractors
Schedule 2—H. C. Price Company
Schedule 3, 4, 5—Stanley-Bledsoe Corporation
River Crossing Contractors
Kootenai and Pend Oreille—River Construction Corporation
Snake River—Missouri Valley Dredging Company

ALBERTA NATURAL GAS SECTION

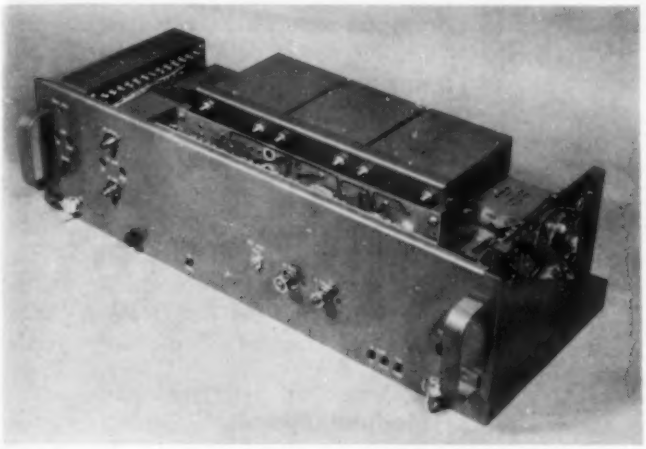
Pipe: Welland Tubes Limited
Outer Wrap: Crose-Perrault Canada Ltd.
Glass Inner Wrap: Peace River Glass Company Ltd.
Asphalt Primer & Enamel: Canadian Kodiak Refineries Ltd.
Internal Coating-Epoxy System: British American Paint Company Ltd.
Construction Contractors
Schedule One—PRICE-POOLE, a joint venture—H. C. Price of Canada, Ltd. Poole Construction Company Ltd. (Also-Double Jointing and Coating)
Mannix Co. Ltd.—sub-contractor to Price-Poole for part of section.
Testing: Mannix Co. Ltd.

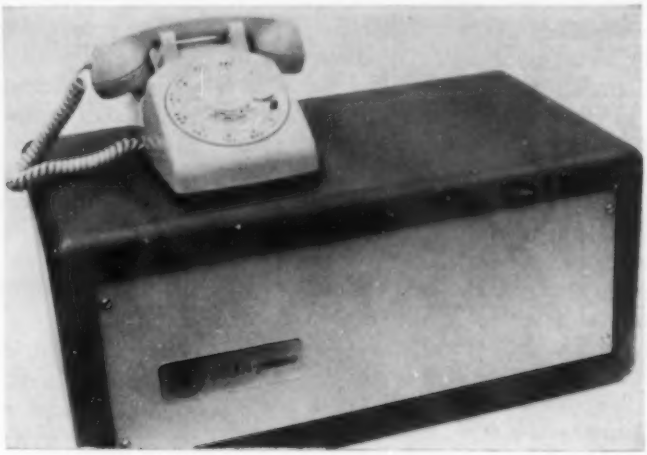
ALBERTA GAS TRUNK LINE SYSTEM
MATERIAL: SUPPLIER

Line Pipe: Camrose Tubes Limited Big Inch Pipe Corporation Ltd. Alberta Phoenix Tube & Pipe Ltd. Welland Tubes Ltd. South Durham Steel & Iron Co., Ltd.
Ball Valves: Rockwell Manufacturing Co.
Gate Valves: Grove Valve, Ltd.
Plug Valves: Walworth Company and Peacock Bros. Ltd.
Valve Operators: Shafer Valve Company
Fittings & Headers: Taylor Forge & Pipe Works of Canada Ltd. Tube Turns of Canada Ltd. Ladish Company of Canada Ltd.
Enamel & Primer: Canadian Kodiak Refineries Ltd.
Glass Wrap: Peace River Glass Company Ltd.
Piping Prefabrication: Master Welding (Calgary) Ltd.
Contractors:
Schedule I, III—Majestic Contractors Limited
Schedule II, V—Alberta Consolidated Pipe Line Builders—a joint venture of Mannix Co. Ltd., Piggott Construction Ltd., Banister Construction Company, Ltd., and Marine Pipeline and Dredging Ltd.
Schedule IV—Dutton-Williams Brothers Limited
Schedule VI—Henuset Bros., Ltd.
Testing—Mannix Co. Ltd.

COMPRESSOR STATIONS AND COMMUNICATIONS-CONTROL SYSTEMS

Station 1 (ANG): Canadian Ingersoll-Rand (Engine-Compressors)
Station 4 (PGT): Westinghouse Electric Corporation (Turbine) The Cooper-Bessemer Corporation (Compressor)
Station 8 (PGT): The Cooper-Bessemer Corporation (Engines and centrifugal compressors) Western Gear (speed increaser)
Station 13 (PGT): Clark Bros. Co. (Engines & Centrifugal compressors) Falk —speed gear
Control System: S. I. E. Division Dresser Electronics
Communication System: Motorola Communications and Electronics Inc.
Multiplex Equipment: Lynch Communication Systems, Inc.
Station Construction Contractors—
Station 1—Marwell Construction Co., Ltd.
Station 4—Eichleay Corporation
Station 8—Kaiser Engineering Co.
Station 13—Kaiser Constructors, Inc.





At the left is a prototype of a 1200 Baud Transceiver. This means the unit can handle 1,200 bits per second. A bit is the smallest of any binary digital code; the term "bit" was derived from the words binary and digit. Right is data phone for operation up to 1,200 bits per second. This unit transmits and receives serialized binary data signals.

PART 1

Data Transmission Simplified

This will help pipeliners understand what until now has often been a mysterious subject

By F. Vinton Long
Texas Eastern Transmission Corp.
Shreveport, La.

MANY A PIPELINER has wondered just what the eggheads were talking about when they get into the subjects of digital telemetering and data processing. In recent years, the subjects have been cropping up with greater and greater frequency; for many have come to regard digital telemetering as some sort of mysterious cure-all for all pipe line system operating ailments.

While the degree of the curative powers of the arcana may be questioned, the fact remains that digital telemetering and data processing will play an important role in the future of most pipe lines, and pipeliners, if they are to make intelligent decisions in this field, must learn the argot. The glossary to be published next month will at least serve as a starter in this regard.

First, why do we use data processing at all, particularly in digital form? It isn't needed unless we are trying for an automatic pipe line—and even then, the volume of communications must be within certain ranges to make the digital system feasible. The greater the volume—the greater the speed of communications, required.

The speed of data handling is determined by the Baud rate, or "bits per second," which, for practical purposes is the same thing.

Now if you don't have much data to handle, probably a low speed transmission will suffice. But if you have a lot of pipe line, and/or you have considerable accounting or other information to feed to a single point, then high speed equipment might be best.

And if you plan to scan the condition of a lot of sales and purchase points and numerous pumps or compressors, then high speed is indicated; otherwise it will take forever for your central office to absorb all the myriad bits of data available to it. If it's not fairly up to date, the data may not be much good.

If the use lease channels for transmission and have a lot of data to handle, then you get more for your money on the higher speed equipment, even though you use a higher grade, more expensive line, such as a $3.00 per month per mile voice grade facility.

Here's how it works:

Leased Cost (Mile per Month)	Capable Speed of Transmission (Bits per Second)	Equivalent Factors	
		Channel Cost % Increase	Bit % Increase
$0.75	15	1:1	1:1
1.50	75	2:1	5:1
3.00	1200	4:1	80:1

So you get more bits for your leased line cost money at the higher speeds. And the equipment required for each end of the line will be about the same

price, if digital data form is used. Don't forget that this does not apply if analog equipment is used. However, if it ever feeds into a computer, somewhere along the line the analog information is usually converted to digital.

If the set point technique of supervisory control is desired, it is necessary that digital transmission be employed. But if neither of these requirements exist forget this digital business. It takes more complicated equipment than does the analog, and is not as easy to maintain. (Moreover, the latter will usually work satisfactorily over noisy transmission channels.)

The circuits for transmission of data are called "trunk circuits" if they are a connection between major switching centers. A "way-operated" circuit is composed of more than two terminal stations, on a "party-line" basis. An example of a "way-station" would be a pump or compressor station as part of entire pipe line system. The number of stations on a way circuit is limited primarily by the volume of traffic each station contributes. This applies both to voice and data handling or telemetering.

For example, the maximum theoretical capacity of a single 75 WPM circuit for an 8-hour day is 216,000 characters, or 36,000 words, so the sum of the traffic from all stations on the circuit obviously cannot exceed this limit. Generally, it is impractical to load a circuit in excess of 75 percent of theoretical capacity.

The only way to handle more traffic or data is to increase the speed, which means you must upgrade the communication channel to a wider band, more expensive one.

A single circuit half duplex provides two-way operation, but in only one direction at a time. A full duplex circuit on the other hand permits simultaneous transmission and reception in both directions. Thus the full-duplex type can handle more load.

Carrier Systems. For high speed transmission of data, frequency modulated or phase shift modulated carrier systems are much preferred over amplitude modulated types. In fact, when you get up to 1000 Baud operation, the amplitude modulation equipment just won't quite make it. I would advise a strong investigation of available transmission lines before buying high speed data handling equipment.

Also, as a general rule, "polar" (changes in current direction) operation is superior to "make-break" (or neutral or on-off) operation, in that it functions independently of current value and with a minimum of bias; therefore, optimum operating margin is inherent, regardless of length or make-up of the conductors, cables, etc. Polar operation also makes it possible to isolate and replace individual circuit components quickly in event of a malfunction, without the necessity for readjustment of the entire circuit.

Modern carrier telegraph systems employ the latest techniques to divide each land line or microwave facility into a number of 3kc channels, known as "voice bands." Each voice band is capable of carrying one voice conversation. Each of these voice bands can be subdivided into a whole spectrum of telegraph channels, separated from each other in frequency. A standard teleprinter channel is 150 cycles in band-width. The carrier equipment enables as many as 20 such channels to be derived from each voice band.

Choice of Transmission Rates. However, for higher transmission rates, (above 100 words per minute), required for the economical transmission of data, greater bandwidth is required, increasing as does the transmission speed, until an entire voice channel spectrum is used to carry one data circuit. As an example, a TV channel, which is essentially an extremely high speed digital handling link, requires a channel many times wider than a conventional voice channel.

There is one point to remember: While high speed data transmission is often necessary to provide an optimum arrangement for moving the data to and from an electronic computer, a single wide-band facility capable of meeting the speed requirement is not always the best answer. The terminal equipment for extremely high bit rate transmission is presently quite expensive, and sometimes alternate solutions are more practical. For example, under certain conditions it may develop that duplicate medium speed data channels with their associated duplicate terminal equipment will be less expensive than a single high speed arrangement, and the duplication will also afford a fall-back in the event of circuit or equipment failure on either of the channels.

Circuits leased for data handling use are customarily rated in bits per second, rather than WPM (words per minute).

The equivalent bit rates for 60, 75, and 100, 5-channel WPM teleprinter service are approximately 45, 57, and 75 bits per second, respectively. In other words, the bit per second rate is about 25 percent less than the WPM rate. Therefore, you can figure up your bit rate and lease a "teleprinter" channel of the appropriate speed.

Medium Speed. Going up a little higher in speed, a new "medium speed" channel is now available, capable of transmission at 180 Baud (bits per second). The channel can use fairly high speed telemetering, or to transmit punched paper tape at about 200-240 words per minute, depending upon the code element (5, 6, 7, or 8 level code) employed. It could also be used to transmit 80 column punched cards at the rate of 10 to 11 per minute.

High Speed. Still higher, and required for at least two telecontrol systems (including data handling) just now available to pipeliners is a 1200 Baud channel offering. Computers may be direct-connected, as well as pipe line supervisory control transistorized equipment. Punched paper tape can be transmitted over this 1200 Baud channel at speeds up to 1100 WPM. Future card transmitting and punching devices are expected to provide 50 cards per minute transmission speed over this facility. It can also transmit punched cards to magnetic tape, or magnetic tape to magnetic tape, at approximately 150 characters per second.

By using two 1200 Baud transmitters in synchronism in a flip-flop method, a 2400 Baud service will soon be available from Western Union. This would permit transmission of punched cards at the rate of 100 per minute, or magnetic tape at 300 characters per second.

Both of these can be used for high speed data transmission or pipe line supervision. However, I think the 1000 to 1200 Baud will suffice.

The only advantage of this transistorized high speed transmission, if you don't use a computer, is the rapid

scanning of pump or compressor station conditions, thus giving you an up-to-the-minute concept of line conditions. You can scan a whole pipe line for pressures, alarms, etc., in a matter of seconds, at a 1000 bit per second rate. In this case, you don't need "upset" equipment, because every minute or so you have the latest report on each station.

It might be of interest to know that a teleprinter "word" is designated as any six keystrokes. Standard teleprinters usually have three banks of keys. The lower case contains the alphabet in capitals and the upper case contains numerals, punctuation marks, and any special characters. You can print-out on almost anything, including carbon sets and multilith masters. As a general policy, for data handling or pipe line control purposes, and when using a typing unit, it is better to arrange the typing format to eliminate carriage shifts. In other words, put all your typing, both numerals and letters, in lower case.

One thing that worries all of us in data transmission or digital pipe line control is error in transmission. As I mentioned before, in slow speed frequency shift telemetering, or sequential tone supervisory control you can hardly miss and can use a line so bad that you couldn't talk on it.

Sooner or later, in digital transmission on a bad line, especially with "white noise" (that is what you see on your TV screen when the microwave carrier fades) you are bound to get an error. This is not so bad in words, but can mess up the whole apple cart in numbers.

In a string of random numbers it really becomes rough.

Since the errors occur infrequently, and the cost of occasional errors in certain businesses is not too great, some customers prefer to accept the occasional error rather than employ an error checking system.

About the Author

F. Vinton Long at 12 years of age was the youngest licensed radio amateur in the United States. After receiving his education in Florida, he continued to follow communications, and spent seven years with Pan American Airways, six years with Mene Grande Oil Company of Venezuela as communications superintendent, three years with the Army Air Force as a communications officer and three years as a special representative of Westinghouse International and Wilcox Electric concentrating on the design and sale of Overseas Airways Communications Systems. He joined Texas Eastern Transmission Corporation in 1950 and is in charge of communications and telecontrol engineering. Long has several patents pending in the electronics field.

Sequential toned supervisory control is still the best, but we can't use it for data handling.

The conventional teletype code is the worst offender. You have probably often noticed your garbled text in a telegram. This usually is not a bust by a pie-eyed operator, but by transmission line interference. The 5-channel telegraph code, consisting of various combinations of "marking" and "spacing" pulses or "on and off" currents, does not in itself provide a self-checking feature. A gain or a loss of a pulse, whether due to "hits" on the line or faulty equipment, will result in an error.

Data transmission usually involves numbers, and the numbers usually involve money, either directly or indirectly.

In such applications, it is often desirable to incorporate some form of error checking system. There are a number of automatic checking systems, varying in sophistication, effectiveness, transmission redundancy, and cost. Also, the speed of transmission in those techniques using double transmission. A balance must be struck between the type of error checking system employed and the volume and relative value of the data being transmitted.

Several systems are:

Parity check—This is based upon distinguishing between an odd and an even number of pulses in the character being checked. For example, the code character for the letter "A" is composed of a first and second pulse, a total of two (even). The letter "B" is composed of a first, fourth, and fifth pulse, a total of three (odd). When the checking device is checking for an even number of pulses, it will accept *any* of the characters that happens to be composed of an even number of them. Likewise, when the checking device is checking for an odd number of pulses, it will accept *any* of the characters that happen to be composed of an odd number of them. While this is an extremely simple check, many times it will prove adequate. There is no transmission redundancy and the cost is quite low.

Then there is the "Binary Weighted" error detection system. This I won't even try to explain here.

Also, the "Protected Number Code," error detection system. Fixed mark-to-space ratio codes as built-in error checking systems are used. The IBM card transceivers and all of Friden's eight-channel equipment use this technique, although the codes are not compatible.

The Bell SC-2 uses a parity check plus a twice-repeat for supervisory control.

Two of the latest highly transistorized systems (1000 Baud or so) use double transmission techniques, with the second transmission being compared with the first before it is accepted. One of these two suppliers does double transmission, but arranges the second one to be the complement of the first, for safety and easier computer compatibility.

Part 2 will present a glossary of terms worth keeping in your notebook.

To Be Continued

Table I—Comparison of Bits, Characters, and Words in 5 and 8 Channel Code

Type of Service	5 CHANNEL			8 CHANNEL		
	Words Per Min.	Characters Per Sec.	Bits Per Sec.	Words Per Min.	Characters Per Sec.	Bits Per Sec.
PWS Telex or Private Wire Systems*	60 75 100	6 8 10	45 57 75	43 54 71	4 5 7	45 57 75
180 Baud Data Channel	240	24	180	173	17	180
1200 Baud Data Channel	1600	160	1200	1151	115	1200
2400 Baud Data Channel	3200	320	2400	2300	230	2400

* Telex and Private Wire systems are presently offered only in 5 channel code. The 8 channel figures apply to use of auxiliary 8 channel equipment over "teleprinter" channels.

Advantages Of the New XC-60 Pipe

Chemistry: Columbium (Cb)—0.05% max; Carbon—0.26 max; Manganese—1.30%

Strength: 60,000 psi min. yield; 78,000 psi ultimate

Weldability: Can be welded at sub-zero temperatures

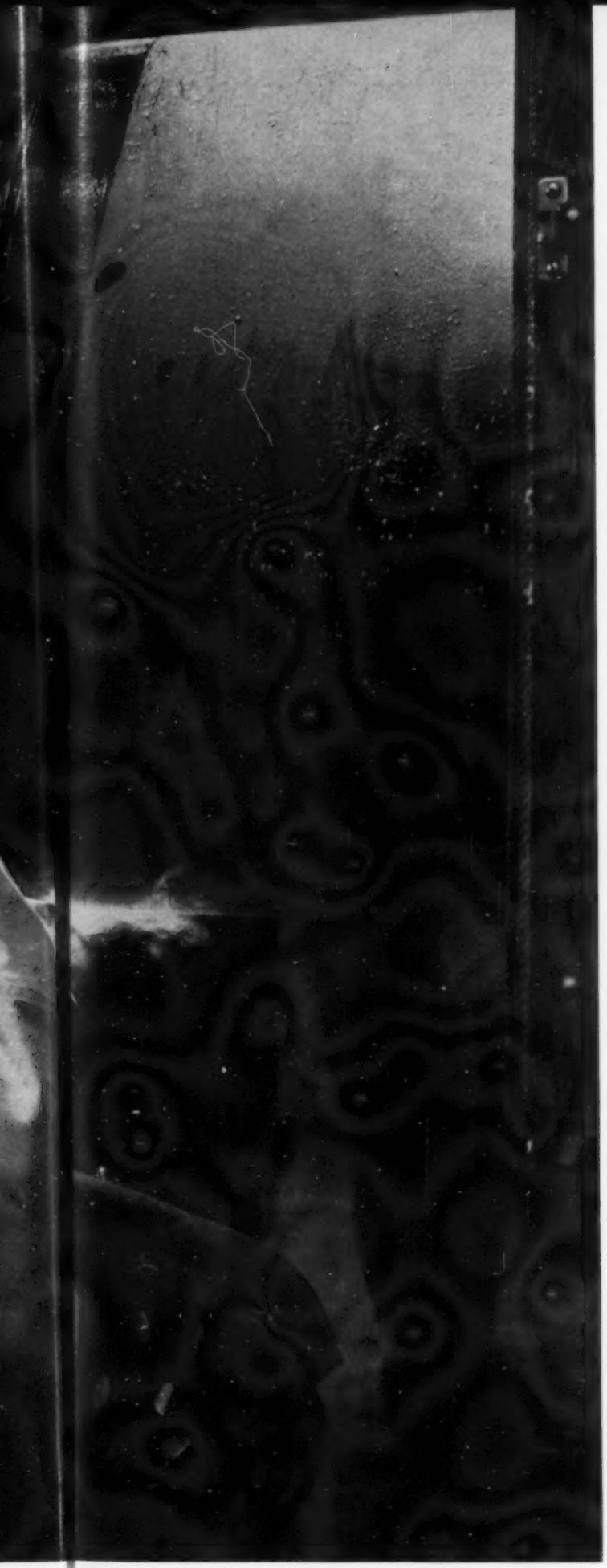
Ductility: Equivalent to that of 'mild steel'

Savings: Almost $6,000 per mile for 26-inch pipe, in theory

By A. G. Barkow, Superintendent of Inspection, Natural Gas Pipeline Company of America, Chicago

FOR SOME YEARS, there has been a real need for a line pipe steel which has a definitely higher yield and ultimate strength; a steel which has notch toughness at lower operating and ambient temperatures; a steel which is weldable without pre-heat at ambient temperatures

FIGURE 1—Welding XC-60 pipe at sub-zero temperatures. The pipe retained its ductility and once "mild steel" welding techniques were adopted, there was no underbead cracking. So far about 50 miles of the new pipe has been laid in 20, 24 and 30-inch diameters. About 1,900 welds were radiographed; only four welds had to be cut out.



lower than can be safely worked under present conditions; and a steel which will have a lower per-foot-cost than present steels, offered to satisfy such advanced designs.

A joint venture in the development of such a line pipe steel was started about two years ago by Natural Gas Pipeline Company of America, Great Lakes Steel Corporation and A. O. Smith Corporation and with the cooperation of H. C. Price Co., who conducted many of the field welding and performance tests. The steel developed for this purpose was based on the then available Great Lakes GLX series of high strength steels. This was a columbium treated steel, having many of the desirable properties sought in the proposed type of line pipe material.

Columbium as an additive to steel has a strong affinity to carbon and also acts as a ferrite former on the crystalline structure of the steel. (Figure 2.) This tends to form a finer grain structure thereby increasing to a higher value the yield and tensile properties. The carbide forming tendency of this element is so strong that it frequently is in the structure as an undissolved carbide and

What Columbium Does to Steel

The addition of columbium (Cb) to steel improves grain structure and achieves higher strength levels with lower carbon-manganese chemistry (about 30 percent lower in carbon and 25-35 percent lower in manganese than the highest strength grade pipe steels now in general use).

The low carbon and manganese contents—which are equivalent to that of mild steels—give the alloy the weldability and ductility of mild steels. While retaining the higher yield and ultimate strengths.

in this way reduces hardenability of the steel, a valuable adjunct to weldability. At the same time it has very little effect on the ductility as measured by elongation and reduction of area.

Thus it is possible to decrease the carbon content without lowering the strength of the material. Since columbium has no detrimental effect on weldability, the decrease in carbon produces a more weldable material in the high strength group.

The basic ladle analysis and physical properties of the pipe set as a goal for this development were as follows:

Chemical

Carbon—0.26% max.

Manganese—1.30% max.

Columbium—0.05% max.

Physical

Yield Strength: 60,000 psi min.

Ultimate Strength: 78,000 psi min.

Elongation in 2 inches. Same as API 5LX for grade X52 pipe steel.

We have labeled the columbium additive steel used in our experiments XC-60. In presenting the following data, we consider this as a progress report with results that are highly encouraging and gratifying. The test program included investigations of steel mill and rolling practices, pipe fabrication, production and testing, welding, bending, laying and actual gas transmission service. Studies of metallurgical and physical properties of the steel during the various stages of production and testing were made throughout the program.

THE MATERIAL

The first experimental pipe made in this program was 24-inch O.D. with 0.250 and 0.218 walls. The second phase of the program was the production and laying of 24-inch O.D. x 0.250 wall and 30-inch O.D. x 0.312 wall pipe. A total of 4¼ miles of 24-inch and 1¾ miles of 30-inch pipe was installed into an operating pipe line. The third phase consisted of the production and laying of 47 miles of 20-inch O.D. x 0.250 wall pipe.

During the first phase, six heats of steel were made using various chemical compositions and combinations to permit the determination of the best range of composition for future work. The following tabulation shows the chemical and physical range of these heats in the "as rolled" condition.

TABLE 1—Range of Chemical Ladle Analysis and Physical Properties of Plate as rolled of First Six Heats

Chemical:	Carbon	0.19% to 0.27%
	Manganese	0.81% to 1.30%
	Phosphorus	0.009% to 0.013%
	Sulphur	0.020% to 0.026%
	Columbium	0.023% to 0.032%
Physical:	Yield Strength	59,000 psi to 71,000 psi
	Ultimate Strength	79,000 psi to 101,000 psi
	Elongation in 2 inch	30% to 38%
	Transition Temp.	10 ft./lb. (—20° F) to (—60° F) 50% shear (0° F) to (—40° F)

(Note: All physical properties reported are in the transverse direction unless otherwise noted. All impact specimens are ⅔ size.)

Plate for the fabrication of pipe was selected from two of the heats of steel (Table 1), one with chemistry on high side. The following are chemical and physical results on expanded pipe made from these plates.

TABLE 2—Chemical and Physical Properties of Expanded Pipe

Chemical:	Carbon	0.23% to 0.26%
	Manganese	1.22% to 1.30%
	Columbium	0.019% to 0.030%
Physical:	Yield Strength	62,000 to 70,000 psi
	Ultimate Strength	83,000 to 96,000 psi
	Elongation in 2"	26.0% to 32.0%
	Transition Temp.	50% Shear (—24° F) to (+16° F)

The second phase in this development program consisted in making production runs on two sizes of pipe—24-inch x 0.250 wall and 30-inch x 0.312 wall. The plate was made at two mills using slightly different techniques to arrive at the same end results. Six heats of steel were used in making 4½ miles of 24-inch pipe and five heats were used in making 1½ miles of 30-inch pipe.

The chemical and physical properties of the expanded 24- and 30-inch pipe are shown in Table 3.

TABLE 3—Chemical and Physical Properties of First Pipe Run

		24"	30"
Chemical:	Carbon	0.21% to 0.27%	0.20% to 0.27%
	Manganese	1.04% to 1.18%	0.89% to 1.20%
	Columbium	0.030% to 0.039%	0.005% to 0.008%
Physical:	Yield Point	67,700 to 72,500 psi	62,500 to 70,100 psi
	Ultimate Strength	86,500 to 93,500 psi	78,300 to 95,200 psi
	Elongation 2 inch	26.0% to 27.5%	28.0% to 32.0%
	Transition Temp. (50% Shear)	(—14° F) to (+32° F) Average (+15.5° F)	(+12° F) to (+31° F) Average (+21° F)

The transition temperature was one of the important factors in this investigation. For this reason a complete series of Charpy "V" notch impact tests were made of each heat in the "as rolled" condition and as finished pipe. Both energy absorption and "percent shear" were used as criteria in reporting these results. It is the author's opinion that "percent shear" is the better criteria for this work. Average results are included in each physical property table.

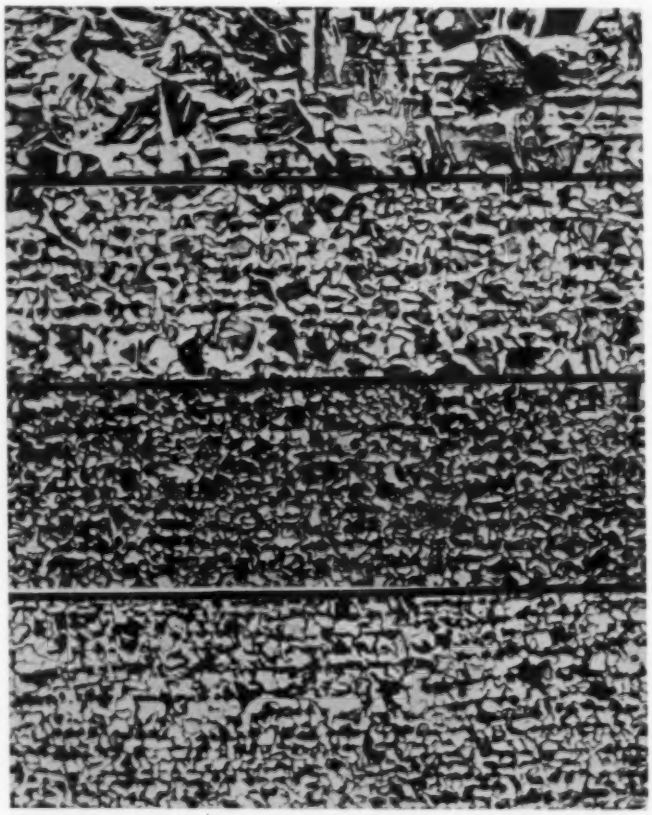


FIGURE 2—The effect of columbium (Cb) on grain structure. The addition of columbium makes it possible to reduce the carbon and manganese contents about one third. This gives the steel the ductility and weldability of mild steel but retains strength of high-chemistry steel.

As a matter of comparison, with steels presently used in pipe lines, the 50 percent shear transition temperatures range of approximately 200 heats of grade X-52 steel was from 20° F to 90° F with an average of 62° F. Two specimens were below 30° F and four below 40° F. In contrast, 36 specimens were above 70° F and five were above 80° F. Figure 3 is a graphic comparison of the Charpy impact values of columbium treated steels and the presently used grade X-52 steels.

The third phase of this program was an actual production run of 47 miles of 20-inch O.D. x 0.250 wall columbium treated expanded pipe. Sixty-two heats of

steel were used for the production of this pipe. Table 4 shows the chemical and physical range of this run of pipe.

TABLE 4—Chemical Check Analysis and Physical Properties of 20-inch O.D. Pipe

Chemical:	Carbon	0.20% to 0.27%
	Manganese	0.89% to 1.28%
	Columbium	0.006% to 0.018%
Physical:	Yield Strength	65,000 to 83,000 psi
	Ultimate Strength	82,000 to 101,000 psi
	Elongation, 2 inch	22.0% to 32.0%
	Trans. Temp. (50% Shear)	(—34° F) to (+50° F)

(Average (+23.1° F): 5 heats 50% shear at below 0° F; 9 specimens 40° F and above).

MANUFACTURE

All of the pipe used in this program was made by the same manufacturing procedures used for flash welded grade X-52 pipe at A. O. Smith Corporation, Milwaukee and Houston plants. The 24-inch pipe was expanded by either the hydraulic or mechanical methods. All 30-inch pipe and 20-inch pipe was expanded by the mechanical methods. Using the same degree of expansion as in normal practice, the effective increase in yield strength was approximately 5,000 psi for the XC-60 grade as compared to approximately 10,000 psi for the X-52 grades. No difficulties were encountered in forming or in welding. All pipe was hydrostatically tested to 90 percent of minimum specified yield for a fiber stress of 54,000 psi.

TESTING

Five burst tests were made on 24-inch diameter pipe during the first phase of testing. Three of the tests were made on full 40-foot lengths and two were made on two 20-foot sections with a girth weld in the center for an overall length of 40 feet each. In all cases, the burst was of a ductile 100 percent shear with an average length of rupture of five feet. The failures occurred in the plate material at yield and ultimate stresses in close agreement with laboratory strip tensile tests results and substantially above the minimum specified. These tests were made at an ambient temperature range of 30° F to 40° F.

During the second phase, three joints of 24-inch and three joints of 30-inch pipe were subjected to hydrostatic destruction tests. Results of these tests again closely agreed with strip tensile test reports. All ruptures were approximately 5 feet long in the plate material and showed 100 percent ductile shear fracture.

During the third run of 20-inch pipe, two burst tests were made on 40-foot lengths of pipe. Both ruptures were about 5 feet long and were 100 percent ductile shear fracture. The failure stress was in full agreement with strip tensile test reports. Table 5 shows the comparison of laboratory reports and actual hydrostatic stresses developed.

TABLE 5—Burst Test Data for 20-inch O.D. Pipe

	Strip Tensile Laboratory Yield Point (PSI)	Burst Test 2% Off-Set Yield Point (PSI)	Laboratory Ultimate Strength (PSI)	Burst Test Actual Ultimate Strength (PSI)
Test No. 1...	80,700	81,600	100,300	99,000
Test No. 2...	67,300	67,200	84,700	81,000

(Test No. 1 of this group developed the highest strength at failure in this program. Test No. 2 was about average for all groups.)

Battelle Underbead Cracking Tests. As a first step in the weldability test program for this material, a series of specimens were prepared in conformity with the Battelle underbead cracking test, described in "A Study of Underbead Crack Sensitivity and Notch Toughness of Steel for Welding Fittings for Pipe Lines" by H. W. Mishler, R. P. Sopher, and P. J. Rieppel.

This test is primarily a bead-on-plate test in which a high state of stresses is introduced on the surface of the plate. Specimens were taken from sections of pipe welded together for the burst tests as mentioned above. Each length of pipe was from a different heat of steel. Two sections were 24-inch x 0.250 wall and two were 24-inch x 0.218 wall. The specimens were saw cut 2 by 3 inches from the pipe sections as shown in Figure 4. Initial plate

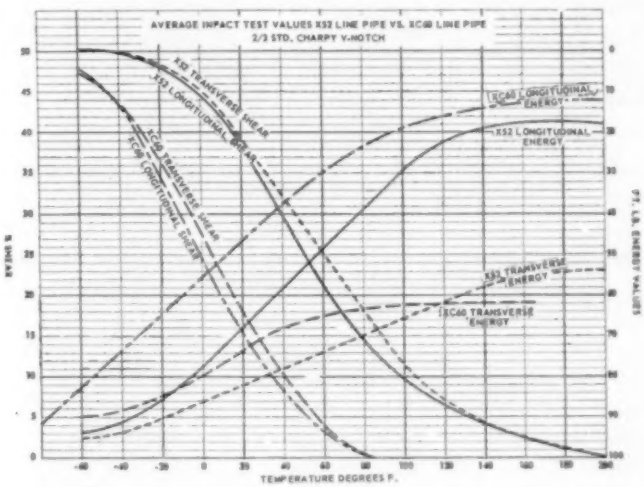


FIGURE 3—Average impact test values of X-52 line pipe vs. XC-60 line pipe—two-thirds standard Charpy V-notch.

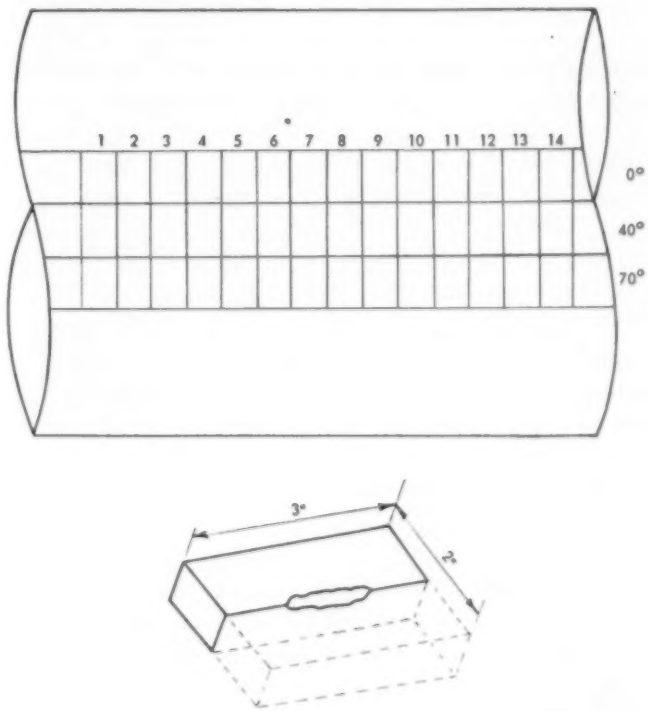


FIGURE 4—Sectioning of underbead cracking test specimens. Welds were made at temperatures ranging from —25 F to 85 F. When mild steel welding techniques were adopted, all underbead cracking was eliminated.

temperatures during welding test were 0° F, 40° F and room (70° F). Ten specimens were used for each test temperature level. All specimens were held at the specified test temperature for 10 hours before the start of welding. A control specimen was used for each test group to measure temperature rise during welding time.

The test welds were 1¼ inches long, welded in 7½ seconds, using ⅛ inch electrodes conforming to AWS specifications E6010. After welding, the specimens were allowed to stand at room temperature for 24 hours and were then normalized at 1650° F for one hour. Each specimen was sectioned longitudinally through the center of the weld and polished to 260 grit, care being taken to prevent heating of the specimen during cutting and polishing. The polished surface was lightly etched and examined under 50x magnification. Each specimen surface was also examined by fluorescent magnetic particle inspection to detect any trace of cracking. *No signs of underbead cracking were found by either method of examination.*

Table 6 compares the results of these tests with similar tests on other steels.

TABLE 6—Relative Tendency to Underbead Cracking of Pipeline Steels as tested in Laboratory for Comparison Purposes*

Material	Thickness Inches	Number of Specimens	PERCENT OF CRACKING-AVERAGE		
			Room	40° F	0° F
5LX52	.344	30	0	2	2.5
5LX52	.500	30	0	2.5	0
5LX56	.406	36	14	22	27
XC-60†	.250	60	0	0	0
XC-60†	.218	60	0	0	0

* Quoted from Battelle Memorial Institute Report on a Study of Underbead Crack Sensitivity and Notch Toughness of Steel for Welding Fittings for Pipe Lines.—"The bead-weld coupon test is a rather severe test and steels exhibiting less than 50 percent cracking in this test rarely crack in full-size girth welds."
† XC-60 specimens were also examined under 50x magnification—no cracks were found in any test group.

RESULTS OF FIRST FIELD-WELDING TEST PROGRAM

An extensive program of field welding tests was conducted at a pipe line construction location, using pipe line welders provided by H. C. Price Company. Four series of four welds each were made at temperatures ranging from —25° F to +85° F. Nipples for these tests were taken from the same pipe used for burst tests. The sub-zero tests were made in a refrigerator railroad car.

Beveling and spacing. Pipe nipples were machine beveled to 30° with a land of 1/16 inch. A 1/16-inch root spacing was also used. The nipples were matched and tack welded before cold storage. Because no power internal clamp was available, a greater than desirable amount of off-set was encountered.

Welds were made using standard pipe line welding techniques. The root pass was either ⅛ or 5/32-inch E6010 electrodes. The second pass was made with 5/32-inch E7010 electrodes; the third pass with either 5/32 or 3/16-inch electrodes and occasionally a 5/32-inch electrode stripper pass. The cover pass was made wtih 3/16-inch E6010 electrode.

The root passes were made at approximately 180 amps and 28 volts, while the remaining passes were made with 200 amps and 30 volts.

All welds were made downhill in a horizontal stationary position alternating in opposite quarters. Pipe was in cold storage for at least 18 hours before the welds were made. No preheat was used. Test nipples were again left to stand in cold storage after completion of the test.

Four test welds were also made by an automatic submerged arc welding process. These were made at ambient temperature ranges of 25° F to 35° F with very high humidity prevailing throughout the test period.

The pipe was rotated in the submerged welding process and all welding was at a point near top center. The bevel was ground to leave a flat land of three-quarter of the wall thickness. Two passes were applied from the outside and one from the inside. Welding speed for the first pass was 90 inches per minute, using 800 amps and 36 volts. The second pass was run at 65 inches per minute, using 700 amps and 32 volts. The inside pass was made at 50 inches per minute, using 500 amps and 34 volts. The wire and flux used was compatible with the E7010 deposit specification. All welds were sectioned to yield from each quarter two tension specimens, one face bend specimen, one root bend specimen and 25 one-half-inch wide macro specimens. Tension and bend tests were prepared and tested in accordance with API Std. 1104. Each of the macro specimens were examined under 50x magnification. Two macro specimens from each quarter were also subjected to Rockwell hardness tests.

The average results of the tension tests are tabulated as follows:

TABLE 7—Physical Properties of Field Welds

		Yield Strength	Ultimate Strength	Rockwell Stock	"B" Hdn. Weld
Manual	High	80,000	98,750	105	95
	Low	72,250	87,750	75	80
	Average	75,600	94,300	89	88
Automatic	High	86,600	105,200	98	95
	Low	74,000	92,200	73	85
	Average	82,000	100,000	90	91

Although the physical properties in all tests were well within the expected range, a number of tensile specimens failed in the weld area, some of which showed shallow cracks in the root area. In almost every case of failure, the adjacent root bend also failed, again revealing minute cracks. This was the most disturbing factor of the entire test. While defects were slightly more prevalent in the welds made at low temperature, sufficient numbers were found in the welds made at higher temperature to indicate that this was a matter of welding technique rather than of material characteristic.

Examination of the macro-etched specimens under 50x magnification again showed the cracks and also gave information on both the origin of the cracks and the distribution. Frequency of occurrence followed no pattern which might indicate that atmospheric or base metal temperature was a factor. Furthermore, the majority of the cracks were almost microscopic in nature, being less than one-half inch long and 0.05-inch deep. Practically all cracks started in a weld defect with internal undercut, lack of complete penetration and off-set welds accounting for most of the offending defects. Many of the cracks starting in internal under-cut, followed the edge of the weld or were in the heat effected zone.

RESULTS OF 2ND FIELD-WELDING TEST PROGRAM

To further study this condition as a weldability problem, a second set of ten welds were made using electrodes supplied by three different manufacturers. Two types of electrodes conforming to AWS-E6010 and E7010 were used in these test welds. Welding heat and welding speed was approximately the same as in the first set of test welds, but somewhat greater care was taken in the welding. However, no line-up clamp was used, and it was again impossible to secure an acceptable line-up of the joints. To provide a comparison, three welds were made with the Standard X-52 grade steel.

The test welds were again sectioned as before and the same type and number of tests were made. The following is the tabulation of physical results of these tests:

TABLE 8—Physical Results of Second Test Welds

		Yield Strength	Ultimate Strength	Percent Elongation
XC-60	High	70,600	90,000	29.5
	Low	62,400	81,900	28.5
	Average	66,000	85,500	29.00
X-52	High	59,400	85,800	32.0
	Low	56,600	81,300	30.6
	Average	58,000	84,000	31.0

One weld gave very poor results because of an extremely bad mismatch of weld edges. All other welds gave satisfactory results on location of fracture in tension tests and all passed root and face bend tests. The X-52 welds were also of good quality, but did have more specimen failures, possibly due to a greater number of defects in the welds.

SOLUTION TO THE WELDABILITY PROBLEM

Further study of welding technique was felt necessary before the material was ready for use. The outstanding difference in weldability characteristic between the columbium steel and the X-52 grade steels was the greater fluidity of the welding puddle in the XC-60 steel. *By reducing the welding heat for all passes, particularly the root pass, and by closing the root gap, to about 1/32 inch, it was found that internal undercutting and lack of penetration could be eliminated and a good internal bead produced with an even flow into the parent metal on both sides of the bead.*

Using this new welding technique, the first 24-inch x 0.250 wall pipe and 30-inch x 0.312 wall pipe was installed with complete welding success. Further, a 47 mile line of 20-inch x 0.250 wall line was installed without the loss of a single weld through cracking. It is therefore felt that this material can be welded without trouble and without danger of cracking, provided it is remembered that the material "welds like a mild steel."

FIELD BENDING

The last phase of field testing of this material concerned itself with cold bending by conventional methods. Four lengths of 24-inch O.D. pipe from the original rolling were used for these tests. Before starting the bending tests, thickness readings were taken at both ends of each length. The average of ten readings gave the following results:

Pipe	Wall Thickness East End	Wall Thickness West End
A	0.234 inch	0.233 inch
B	0.234 inch	0.238 inch
C	0.204 inch	0.204 inch
D	0.226 inch	0.223 inch

In each case, the pipe was bent to failure by buckling. Pipe A was pulled to ½° set on one foot centers to 8½° with a smooth bend and no buckle. A slight buckle occurred after several pulls to ¾° set. Pipe B was pulled to ½° set per one foot centers, with several pulls made to ¾° set. A smooth bend of 14° total was achieved in 21 pulls. Pipe C had the thinnest wall of all pipe tested (0.204 inch), and several successful pulls were made at ½° set and 18-inch centers, but a slight buckle at this point indicated this to be the top limit for good bending. A pull to a ¾° set buckled the pipe. A smooth buckle-free bend was achieved with ⅓° set at one-foot centers.

Analyzing the pulling and bending of this pipe, it was concluded that a greater pull was required to effect the initial set and that each pull had to be a greater arc to effect the desired set due to the "spring back" or return to the original straight pipe. It was also found that a buckle will appear more rapidly and more severely if the limit of pull is exceeded, but that with the right amount of pull, the set will be smooth and the final completed bend will be without measurable signs of waves.

Audigage thickness readings taken before and after the bends were made gave such close results that no determination of thickness change could be detected. Diameter readings were also made before and after the bending. These readings were taken in four planes at the ends of the pipe and in the center of each bend. The following tabulation gives results of these tests:

TABLE 9—Maximum Difference Between Diameters after Bending

PIPE	East End	1st Bend	2nd Bend	West Bend
A	0.464"	0.719"	0.552"	0.499"
B	0.216"	0.313"	0.459"	0.496"
C	0.603"	0.218"	0.420"	0.390"
D	0.298"	0.372"	0.732"	0.123"

The erratic results of these measurements do not lend themselves to an analysis. The indications are that a change in diameter or ovality of approximately 0.250 to 0.500 inches occurred in this bending test. It was concluded that bending could be satisfactorily accomplished

About the Author

A. G. Barkow, superintendent of inspection, Natural Gas Pipeline Co. of America, has been active in metallurgy and welding research for almost 30 years. Since joining Natural Gas Pipeline Co. of America in 1940, he has worked on the inspection of their construction projects and on several field welding studies. During this time he has served on committees of AGA, API, ASME, AWS and he has authored numerous technical articles. (See July 1958 PIPE LINE INDUSTRY, Page 36.)

with field bending equipment and in a length of radius that would be entirely satisfactory. Later experience substantiated this conclusion.

To check the effect of cold working due to the bending, tensile specimens were taken from the ends, outside radius and inside radius of bends of each pipe. The tensions tests were taken in a longitudinal direction, since the working effect of the material was in this direction. The following table gives results based on an average of four specimens each.

TABLE 10—Results of Field Tension Tests After Bending

Specimen No.	Yield Strength	Ultimate Strength	Elongation Percent In 2 Inch
A E	85,400	105,600	27.0
B E	80,600	102,200	27.0
C E	70,700	94,250	28.5
D E	70,700	93,350	30.0
AOR	89,475	102,100	25.5
BOR	91,750	105,220	25.7
COR	80,020	99,800	26.0
DOR	77,000	94,800	28.0
AIR	82,400	105,375	23.5
BIR	79,900	102,275	28.0
CIR	70,050	97,050	27.2
DIR	73,075	92,425	28.0

E = End. OR = Outside Radius. IR = Inside Radius.

Examination of this table shows a gain in yield strength at the outside radius of approximately 8,000 psi and no perceptible gain in ultimate strength. At the inside radius a gain of approximately 1,500 psi in yield strength was noted with no gain in ultimate strength. A reduction in ductility of approximately 2 percent was noted for both outside and inside radii. These figures would be in line with gain in cold expanding in the fabrication of the pipe where a similar degree of cold work is applied.

GENERAL LAYING EXPERIENCE

Based on the results of these tests, approval was obtained to include 4½ miles of 24-inch x 0.250 wall pipe and 1½ miles of 30-inch x 0.312 wall pipe in the 1960 construction program. Both of these sections were in rolling country, requiring numerous bends. Both phases of these installations were carried out without difficulty of any sort. The welders instructed on the characteristics of the material, reported no difficulty. In fact, the consensus of opinion was that columbium treated steel was more readily weldable than the normal grade X-52 pipe. Bending also presented no problems. Bending foremen recognized that greater springback was encountered, but also reported that the bends were more uniform and that they were well satisfied with the bends produced.

Early in 1961, a 20-inch x 0.250 wall pipe line of 47 miles was laid using columbium treated steel throughout. Again, no difficulty was encountered. The stringer beads were cleaned by grinding. *About 40 percent of the welds were radiographed; and the results were so consistently good that it can be concluded that this line is probably more devoid of welding defects than any line ever built. Only four welds out of 1900 inspected were cut out because of defects! No cracks were found. The line was pressure tested without incident.*

ECONOMICS

This test program indicates that the columbium additive steel is a material suitable for pipe line application.

The one question which remains is: "Is this material commercially economical?"

We have found that a higher design strength can be utilized with complete safety. This means that a lighter wall pipe can be used. Consequently, a savings in steel tonnage will be realized; also a savings in freight can be figured.

The lighter wall pipe will cost less to weld and to handle in the field.

It is indicated that the higher price of this steel will be out-weighed by the benefits, thus giving a real economic advantage as well as a theoretical advantage. Figure 5 gives a comparison based on real and extrapolated cost figures. This graph is included only as an indication of possible savings.

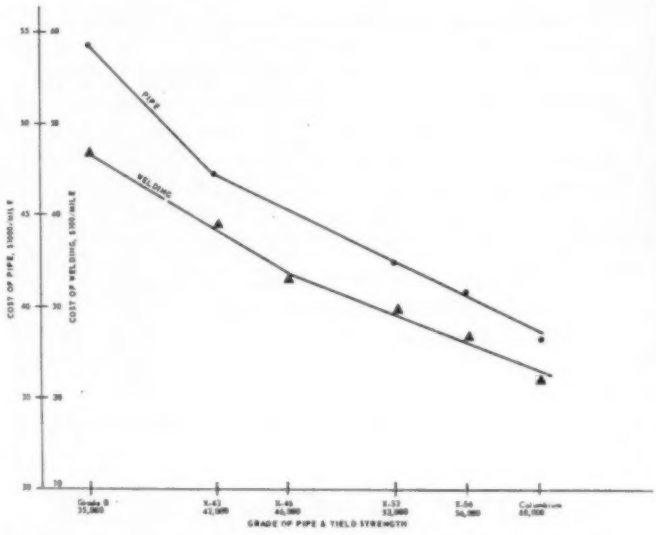


FIGURE 5—Theoretical cost comparisons of building 26-inch pipe lines with various kinds of steel. Advantage comes from higher strength per weight, improved weldability and ductility.

Analysis of chemical and physical properties indicate that a columbium bearing steel having the following properties will approach optimum desired properties for line pipe use:

Carbon	0.26% max.
Manganese	1.30% max.
Columbium	0.05% max.
Yield Point	60,000 psi, min.
Ultimate Str.	78,000 psi, min.
Elongation	Same as API 5LX Gr. 52

Pipe fabrication presented no unusual difficulties. Hydrostatic destruction tests made to date, resulted in 100 percent ductile shear type failures.

Field welding gave no difficulty except for a very minor change in welding technique.

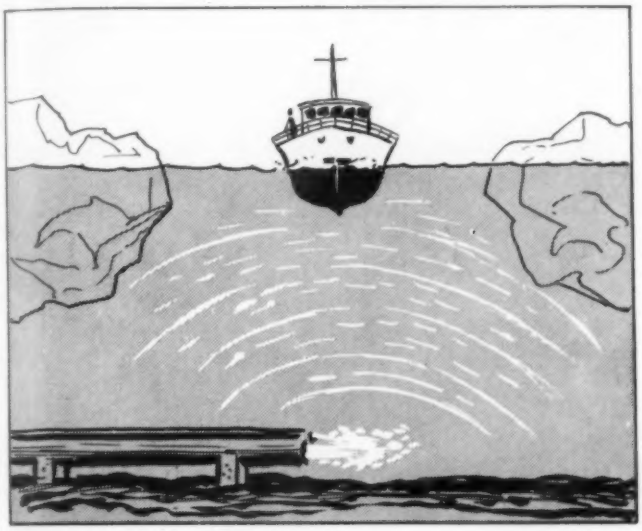
Field bending gave excellent results even in very light wall pipe. Economic considerations are favorable to substantial savings.

ACKNOWLEDGMENT

The writer wishes to acknowledge the cooperation and help received during this program from Great Lakes Steel Corp., Messrs. W. D. MacDonnell, C. L. Altenburger, F. A. Bourke, and W. F. McGarrity; A. O. Smith Corporation, Messrs. H. Detrick, T. Creden, G. E. Fratcher and E. H. Uecker; H. C. Price Company, Messrs. H. C. Price, A. Reutzel and B. Elliott; and Natural Gas Pipeline Company of America, Messrs. M. V. Burlingame, K. Bentz, D. C. Palm, M. J. Paul, J. E. Thompson, M. L. DeCraene, and M. M. Whitson. The writer wishes also to express his appreciation to the above mentioned companies for permission to release this data to the industry. Finally, the writer acknowledges the help of welders, technicians and associates in conducting the tests, preparing the specimens and developing the data.

Ideas for the Future

By **Donald M. Taylor,** Engineering Editor



Submerged combustion of petroleum products to keep harbors free of ice?

Many of our oil companies are looking for new uses for petroleum products to take up the slack caused by high-mileage compact automobiles and the inroads of other fuels. Some of the ideas seem highly fanciful at first, but on second glance show promise. One such idea which is being given serious consideration by Standard Oil Co. scientists is that of submerged combusion of petroleum to keep rivers, harbors and certain seaways free of ice in winter. This could revolutionize shipping in arctic regions, making year-round ports of those normally ice-locked in winter.

LPG floodlights for after-dark construction have high efficiency

Lightweight floodlights constructed of aluminum and burning LP gas will prove to be a handy addition to the pipeliner's kits of construction tools.

A high efficiency aluminum reflector and high efficiency burner provides light up to 15,000 reflected candle power. It can be maintained for 50 hours at a tank pressure of 15 pounds and 150 hours at 30 pounds. These portable lights will prove handy to pipeliners who must perform emergency repair jobs at night.

Materials with tensile strengths of several million psi produced in lab

It may sound far-fetched today, but quite likely the time will come when we have steel and aluminum alloys with tensile strengths running into several million psi. Research scientists are producing such materials in our laboratories today.

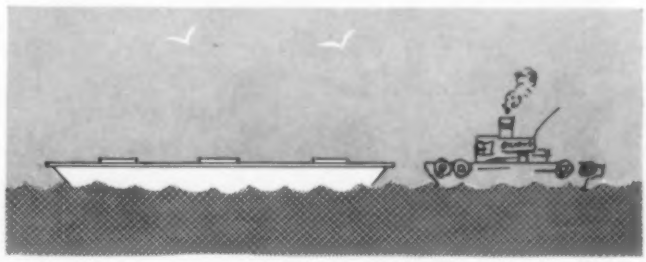
General Electric for instance has been combining sapphire whiskers with aluminum in an attempt to produce an ultrastrength composite material. Single crystals grown from aluminum by evaporating it in hydrogen that contains water vapor have exhibited amazing strength. The next step, says Dr. Willard H. Sutton, of the company's missile and space vehicle department, will be to develop composites using steel or refractory metals.

Underwater electrical explosions forge metal in GE laboratory

From GE's General Engineering Laboratory at Schenectady, N. Y. comes a new idea in forming metal. Here's the way it works: Metal is placed in a die under water. Electrical energy is built up to the point that it produces an explosion that directs high-intensity shock waves against the metal causing it to take the shape of the die. Prior to forming, the die must be evacuated to prevent irregularities on the metal's surface.

So far, metal pieces up to 10 inches in diameter and 1/16th in thickness have been formed by the process. Voltages have ranged up to 35,000. Higher potentials are planned for the future.

Metals shaped in this manner include molybdenum, titanium, stainless steel, etc.



Aluminum barge will be used to haul petrochemicals from Texas plant

Todd Shipyards of Houston will construct an 86-ton aluminum barge for Reynolds Metals Co. It will measure 98-feet by 35-feet, and it will be used by Industrial Marine Service Co. of Memphis to transport perchloroethylene from Diamond Alkali's plant at Deer Park, Texas, to points along the Mississippi and Ohio rivers. The cost, says Reynolds, will be about the same as that of a comparable steel barge. The increased cost of metal is compensated by the lowered cost of fabrication.

West Shore Line Squeezes Through Congested Areas

New products line that runs from Chicago area to Milwaukee and Green Bay has over 500 cased crossings. In open country there were peat bogs and rock

DE-WATERING DITCH. Well points at right keep ditch free of water on West Shore construction. On Job 1 is Midwestern Contractor's pipe gang laying 16-inch through trailer park area alongside old railroad right-of-way.

By Melvin A. Judah

THE WEST SHORE PIPE LINE COMPANY system, now under construction and scheduled to commence operations in December, probably required as much meticulous detail in its field engineering as any products line ever laid. Much of the route of the line passes through congested areas where hundreds of "foreign" lines—sewers, water and gas lines and telephone cables—had to be accurately plotted on the maps and staked out for construction. Also, there was the problem of sharing and crossing other rights of way—especially those of highways and railroads.

The accuracy of this engineering was reflected in the pace achieved by a number of contractors on this job, and the credit should go to the engineering staff of Interstate Oil Pipe Line Company of Shreveport, La. (Now Humble Pipe Line Company of Houston) which handled the engineering on this joint venture.

The route of the 285-mile-long 16 and 10-inch products system is shown on the accompanying map. The products from the many shippers will enter the system in the Chicago area at Hammond and Romeo stations. Deliveries will be made at various points along the system to include Jones Island, Granville (near Milwaukee) and Green Bay, Wis.

The initial capacity of the system will be about 85,000 barrels per day with pumping stations at Bell and Granville. The capacity can be in-

BLAST FURNACE SLAG HAD TO BE BLASTED before Deck Road Boring Co. could bore beneath the Indiana Tollway crossing. Note tractor ripping slag prior to boring operation which was subbed to Deck on Job 1.

creased substantially by the construction of additional pumping stations.

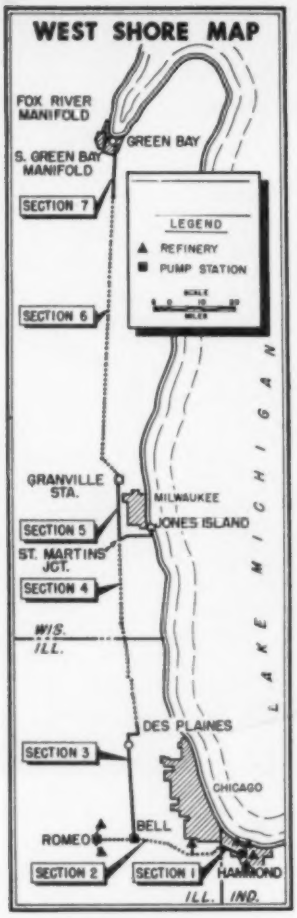
The line will be a common carrier and there are a number of participants and part owners other than Humble Pipe Line Company. They are: American Oil Company, Cities Service Company, Clark Oil and Refining Corp., Continental Oil Company, Mobil Oil Company, Ohio Oil Company, The Pure Oil Company, Shell Oil Company and Texaco Inc.

Construction of the Line. The construction of the line was divided into seven different jobs which were awarded seperately to contractors. The successful bidders were: Midwestern Contractors, Inc., Wheaton, Ill.; Contracting and Material Co., Evanston, Ill.; Houston Contracting Co., Houston, Texas; Somerville Construction Co., Ada, Mich.; and Panama-Williams Corp., Houston, Texas. The successful bidders on the coating and wrapping of the 10 and 16-inch pipe were Hill Hubbell Pipe Coating Co. of Cleveland; Pipe Line Service Corp. of Franklin Park, Ill.; and the Irish Pipe Coating Co., Inc. of Shreveport, La.

Over-all Construction Plan. All of the pipe was coated in yards—seven in all—and then strung along the right of way much of which wound in and out between roads, railroads and industrial sites. As the pipe was welded into the line, it was field coated at the joints and of course, any damage to the coating was repaired prior to lowering-in.

Added to the many problems normally associated with laying a line in the greater Chicago and Milwaukee areas and suburban country nearby, was the necessity to de-water much of the ditch plus a variety of rock problems. There were some 500 cased crossings on the line, and there prob-

THE 3,754-FT. CROSSING of McGinnes slough in Cook County Forest Reserve. Contracting and Material Co. floated pipe across slough on drums, released it in shallow water and jetted it into the bottom.



ROUTE OF WEST SHORE SYSTEM. The 16 and 10-inch products line will receive "cargo" at Hammond and Romero stations. It will deliver to terminals at Jones Island and Granville (near Milwaukee) and to Green Bay.

PIPE LINE PASSES UNDER TREE! Contracting and Material's Spread 3 laid some 23 miles of 16-inch line along Highway 83 near Chicago. In many areas plans for future road construction required that the West Shore line be laid deep: in several instances, to depths ranging from 20 to 25 feet. Here, along Route 83 pipeliners bored beneath a tree to get the pipe deep enough for a cut on the other side.

BUSY BACK HOES. Back hoes ditch alongside Highway 83 near the point where Highway 66 turns towards Chicago. Plans call for widening of Route 66 which meant the West Shore line had to be deep and cased for several hundred feet.

ably would have been more had the right of way not followed streets, railroads and highways in several sections. Although there wasn't a lot of solid rock there were many miles that had their share of boulders, blast furnace slag, soapstone and other hard ditching. Here is a spread-by-spread report as construction progress moved toward completion.

Job 1. Midwestern Contractors, Inc., laid two miles of 16-inch main line and 8 miles of 16-inch receiving lines from shipper's tank farms and terminals into the Hammond, Indiana pump station site. All of this section was located in Lake County, Indiana and most work was through congested areas. Virtually all of the ditch had to be de-watered with well points; there were a number of major cased crossings including one that had to cut through tightly packed blast furnace slag under the Indiana toll road and Calumet Avenue for a distance of 975 feet with 6½-7 foot of cover. Length of bore for the 20-inch casing was 254 feet. Sub-contractor for the crossings on Job-1 was Deck Road Boring of Corpus Christi, Texas. Midwestern laid pipe along an old railroad, through a trailer park and on power line and street right of way on most of this Indiana work.

Job 2. Contracting & Material Co. had the contract for 32.4 miles of 16-inch main line plus over 3 miles of 16-inch receiving lines. The main line crosses several miles of Cook County Forest Preserve with special requirements for topsoil spreading, strict timber cutting regulations, etc. Here again, ditch required de-watering and there was one major stretch of water work. The 3,754-foot crossing of McGinnes Slough in the Forest Preserve was shoved across and jetted in after lowering to the bottom of the shallow lake. On the power line right of way in the Tinley Park area the center of the pipe line was only five feet from the property line and necessitated working on the spoil bank.

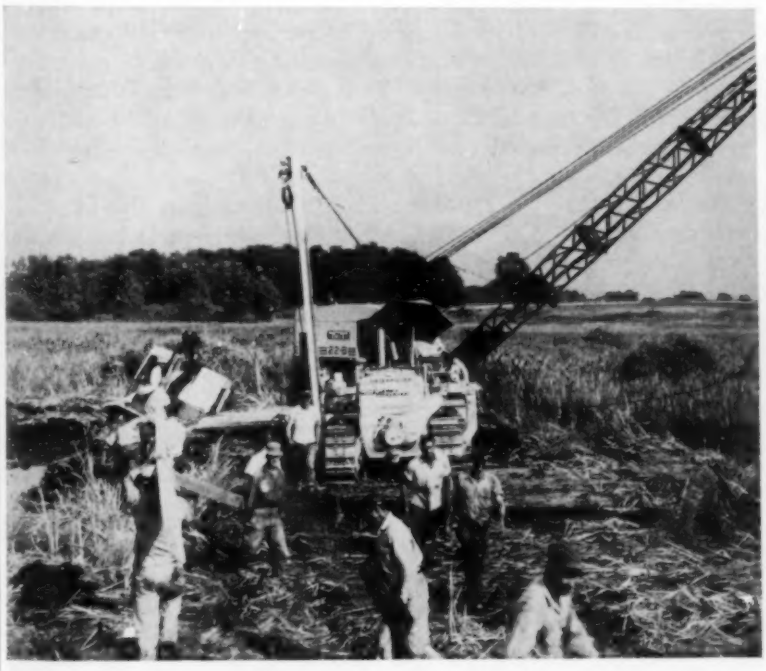
Receiving lines extend from The Pure Oil Company's refinery near Lemont and Texaco's at Lockport to West Shore's Romeo station. Much of Contracting and Material's work here was along highways and railroad routes. Some soapstone was encountered in the bottom of ditch cut to 51-inch depth; but wheel trenchers were able to handle it.

Job 3. Contracting and Material Company was the successful bidder on this section also. This work consists of 32 miles of main line and a mile of 16-inch line into Des Plaines. Some 23 miles of Job 3 paralleled Highway 83 and laying on this heavily traveled right of way called for plenty of ingenuity on the part of the contractor. Norman Wilkerson was the spread superintendent. Feeder road and interchanges required deep cut

CONFERENCE AT McGINNES SLOUGH. Contracting and Material Co. vice president Dick Cagney, center, discusses crossing problems with company's Spread 2 superintendent, Bill Reeds, left, and pipe line superintendent Bob Jones, right.

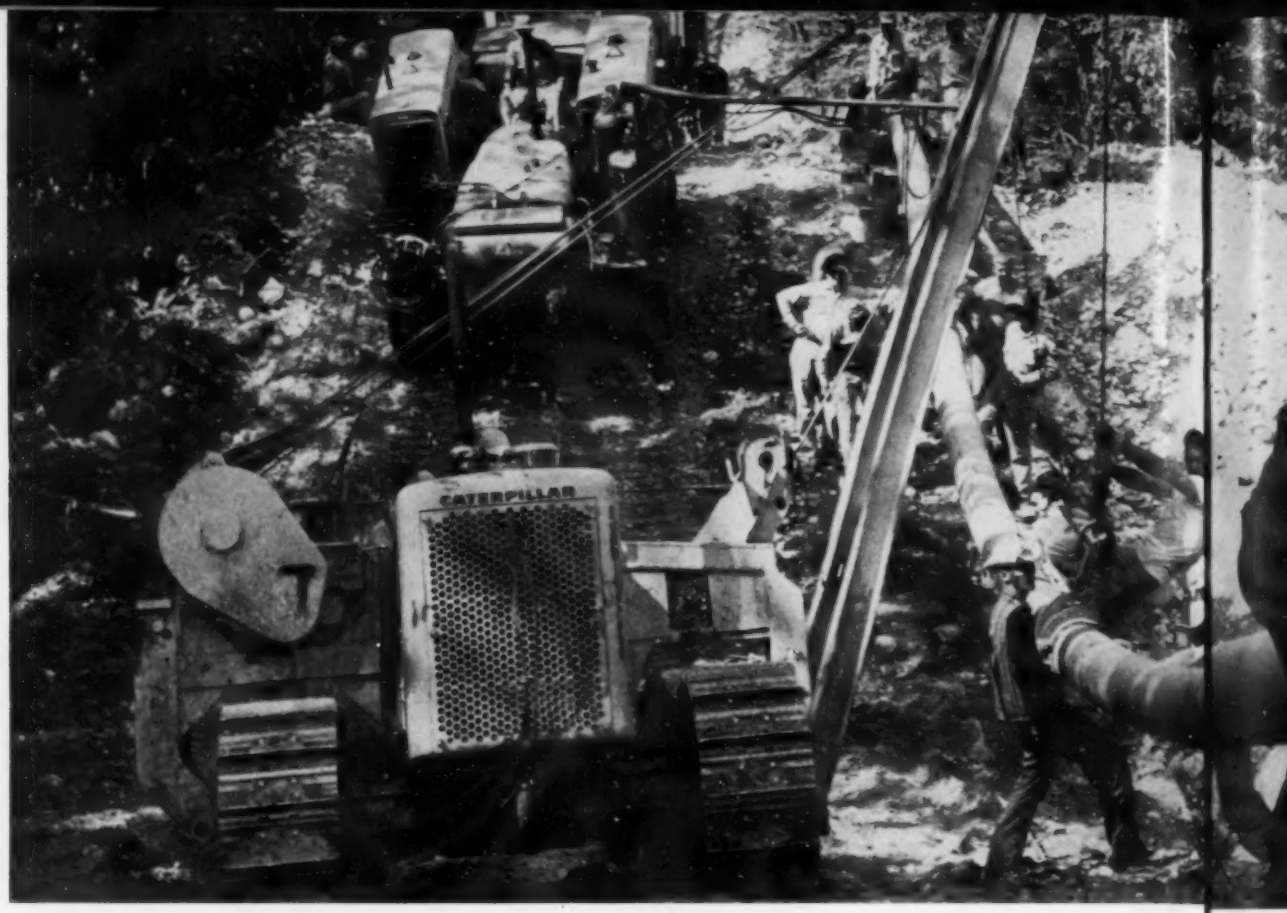
casings in many areas and cuts to more than 20-foot depths were not unusual. This called for ditch shoring and in at least one instance boring beneath a live tree . . . this was one time when the welder did not need an umbrella. He was in almost 20 feet of ditch and under a shade tree. This section of West Shore also crosses the famed Route 66 which is to be widened. This required deep and long casings.

Job 4. Houston Contracting Company completed the 61 miles of main line between Des Plaines and Milwaukee. Some 20 miles of this section



CASUALTY OF A PEAT BOG is the backhoe barely visible at left. Here Houston Contracting retrieves the back hoe which started to sink in bog.

ALL-HYDRAULIC trencher on Job 4. Tracks, wheel and conveyor are run by identical hydraulic motor units.



TIMBER LAID FOR GAME COVER. On Job 6 Panama Williams Corp. laid 76 miles of 10-inch between Milwaukee and the Brown County line. In the Kettle Morain Forest Preserve Area. Forest authorities required that the timber be thrown off the right of way to provide small game cover.

of 16-inch was laid on railroad right of way. While laying pipe along the railroad simplified R-O-W procurement problems, it required working in tight areas and many bends were needed to clear stations and yard connections. The pipe line was staked only five feet from the railroad property line so it made for tight work between the track and the ditch.

Almost half of the work on Job 4 ran through resort country in Lake County, Ill. Diplomacy and good landowner relations were a must for both the contractor and West Shore personnel. While there was a minimum of hard rock on this section there were plenty of boulders to abuse ditcher conveyors and block road boring on cased crossings. A few peat bogs also added to the difficulties. But in spite of this, Bill Bruyere, Houston Contracting's chief engineer reported that Houston's top construction day tallied up to 16,129 feet of pipe welded. Jack Slovak's spread started June 27 and laid out August 7 or 41 elapsed days for 61 miles working a six-day week.

Job 5. Pipeliners with Somerville Construction Company which is laying the 36 miles of main line and 7½ miles of delivery laterals in Milwaukee and Waukesha Counties could see the Braves play every night (if they were scheduled at home). All of this 16-inch work is within sight of Milwaukee's skyline and much of it is in the city. Delivery lines will serve six shippers at the Jones Island Terminal at the Port of Milwaukee. Three other shippers are to take deliveries in the Granville Station Area. Much of Somerville's work in the Milwaukee area was either on railroad right of way or along streets; roadbuilding is a big part of the work and progress on this section may well be the toughest and slowest.

Job 6. Panama-Williams Corporation had the contract for 76 miles of 10-inch main line from the Granville Station site northward to the Brown County line. Terrain crossed by superintendent Emmett Sutton's spread varied a great deal, but it was generally wooded, rolling and somewhat rocky with some marsh work thrown in for good measure. The Kettle-Morain resort country through which much of the route passes is a lot better for sight-seeing than pipelining. The best day's progress on this line at the time of our visit to the spread was 292 joints welded out in one day; but the spread was crossing washboard hills near Greenbush, in the Kettle-Morain forest the day we were there, and they had made only 71 joints by 4 o'clock.

Several sections of Panama-Williams' job required blasting and there were plenty of boulders to slow ditching and road crossings. Rock fences which are common in this area also were another obstacle to the clearing gang. In the Kettle-Morain forest preserve area the timber was heavy; to provide cover for game, authorities requested that the contrractor pile cut timber off of the right of way. This saved burning time and any possible fires. In some stretches of Job 6 the conservation department wanted the ditch left open in low areas to provide drainage and to harbor small game and waterfowl. The 5 foot ditch was dug 12 feet wide at the top and five feet wide at the bottom. In those areas pipe will be continuously covered with water until natural sloughing and soil falldown occurs.

RUBBER TIRED SIDEBOOM LOADER paid off on work in Green Bay. It doubled for stringing, handling de-watering equipment, backfilling and variety of spread jobs on this 10-inch lateral north of Green Bay.

Job 7. On the northern end of West Shore, Somerville Construction had to do a little bit of everything. This segment comprises 22½ miles of 10-inch main line and over 6 miles of 10-inch delivery laterals all in Brown County, Wisconsin. Again much of the construction was through game preserves, city parks, on railroad and power line rights of way and in generally restricted areas. A two mile stretch of this 10-inch line parallels a railroad and the line was staked within 7½ feet of the rail.

West Shore's line curves down a rock cliff at a fault line south of Green Bay. Because the cliff is one of the highest points in that part of Wisconsin it naturally attracted a number of TV and radio transmitter towers, and the route selected for the line passed directly beneath two of the guy wires for Green Bay's Channel 5: there was a stretch of rock just at this point. Since no blasting was permitted under the guys, making ditch called for considerable ripping and backhoeing.

ACROSS FOX NEAR GREEN BAY. Pentzien, Inc. had contract for laying single 10-inch line across Fox River at Green Bay. The 0.438 wall pipe for river line has 2-inch concrete coating. It crosses the navigable Fox River and underneath power lines.

Fox Crossing by Pentzien. The largest river crossing on the West Shore system is that across the Fox River at Green Bay. Pentzien, Inc. was contractor for the single 10-inch line. River pipe is of 0.438-inch wall with coal tar, asbestos wrap protection plus 2 inches of concrete. Bottom of the Fox River was dredged prior to laying the pipe. The meter installations for the northern delivery terminals will be located near Texaco's terminal and the manifold assembly for other terminals located near the Mobil terminal on the west bank of the Fox.

Company Officials. P. H. Hunter is president of West Shore. Interstate personnel loaned to West Shore to supervise the design and construction of the line include Wayne T. Corley, general manager; A Vernon Cardin, assistant general manager and construction superintendent; D. C. McKinley, project engineer, and L. V. Dennis, manager of claims and right of way. Company construction headquarters are at Des Plaines, Ill.

Station and terminal work is now under way. The system will not commence operations until sometime in December. —The End

How Pipeliners Came Out with Carla

The hurricane was probably the most severe of the past century. However, pipeliners were ready.

By Donald M. Taylor
Engineering Editor,
PIPE LINE INDUSTRY

HURRICANE CARLA was probably the most severe storm to hit the United States in the past century. This fact may never be verified, however, because the past inaccuracies inherent in storm reporting leave much to be learned of earlier great storms such as the one which struck Galveston at the turn of the century.

However, from the standpoint of energy expended, Carla was impressive. One weather scientist said the storm's energy release was equivalent to about 7 million atomic bombs of the size dropped on Hiroshima! The damages inflicted by Carla have been rated at about $500 million!

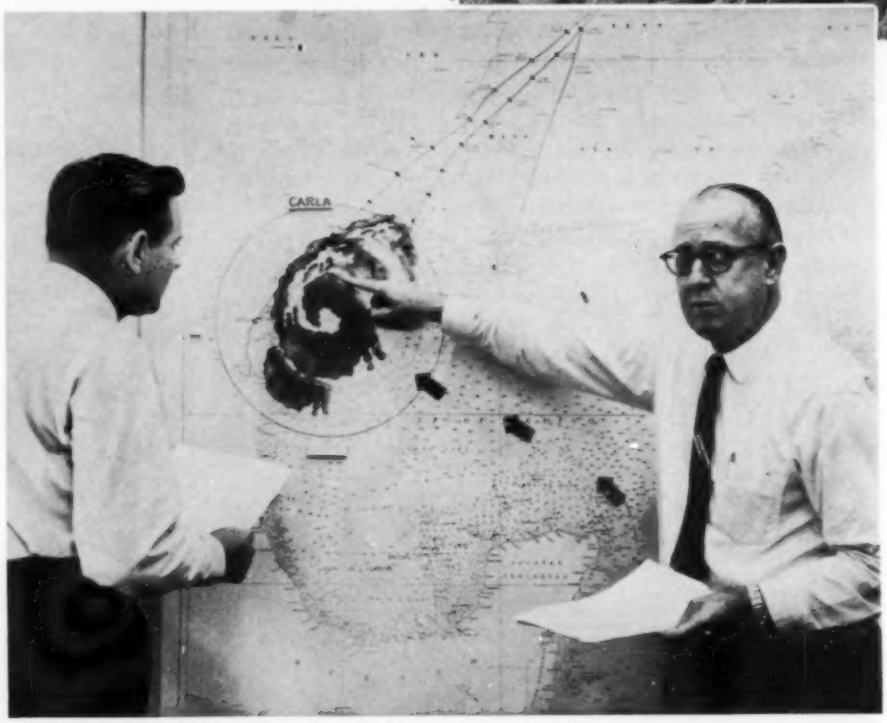
But despite the great force of the storm and its fantastic record of destruction, pipe line installations in its path sustained only minor damages. Most pipe line companies have estimated damages at only a thousand dollars or so. The single exception was a company which lost about 20,000 barrels of crude oil when two of its ship loading lines laid along the side of a causeway were ruptured.

For the most part, the credit for low damages goes to the engineering designs. Pipe line installations lying in the hurricane belt along the Gulf have simply been designed to withstand hurricanes; and the fact that such installations weathered even such a great storm as Carla came as no surprise to most engineers.

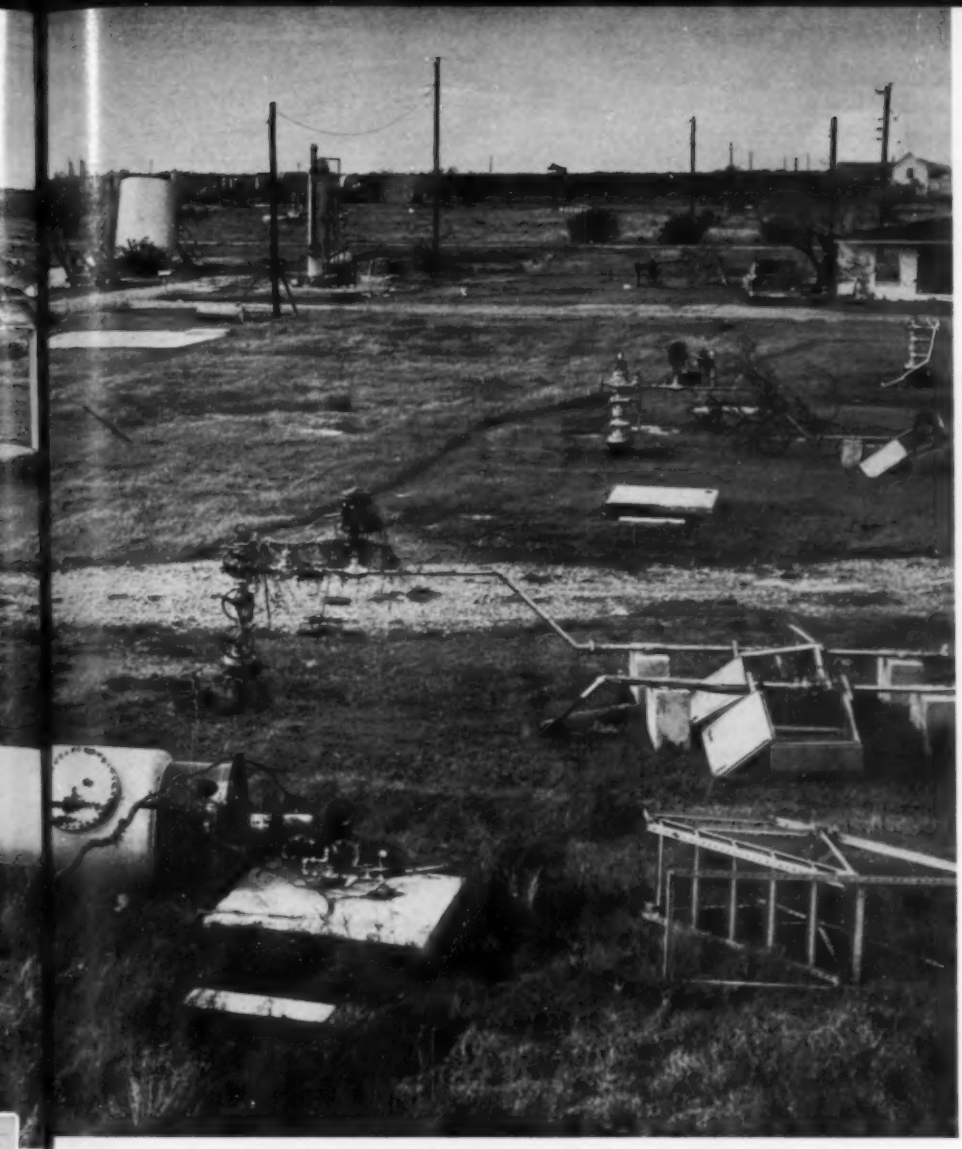
Pipe line delivery schedules however, were strongly affected by Carla. Thruput from crude and products lines were curtailed by refinery shutdowns; and gas lines were affected by gas well shut-ins which came during the storm. Tennessee Gas Pipeline Company, for example, found its supply of gas in the Gulf Coast area about 750 MMcf below normal on September 9; 1 billion below normal on the tenth; 1.2 billion below normal on the eleventh; 800 MMcf below normal on the twelfth; 500 MMcf below normal on the thirteenth and back to normal on the fourteenth.

Fortunately, Tennessee Gas was able to make up the difference between its supply and deliveries by taking gas from underground storage in the market area—up to 626 MMcf per day—and also by depleting its line-pack which runs in the neighborhood of 8.5 billion cubic feet.

According to Tennessee Gas' Ray Davis, who heads up gas control, the biggest difficulty came on Friday Sep-



THE PATH OF CARLA cut directly across the south end of "pipe line alley." Here in the Tennessee Gas Transmission weather center, Ray Davis, head of gas control, points to where hurricane's eye crossed the Texas coastline. Bob Murray, TGT weather-gas control engineer, checks a report. Key weather personnel at TGT spent most of five days in this weather plotting center, probably the most advanced of its type in private industry.



HOW AN OIL-GAS FIELD LOOKS AFTER MEETING CARLA. This field at Olivia, Texas, on an eastern arm of Lavaca Bay was directly in the path of the storm's eye. Winds were recorded as high as 140 mph and one observer estimated gusts up to 173 mph. Real damage came from tides pushed inland by the advancing storm and then churned with devastating force. Virtually all meter runs were destroyed; at least one tank was missing from each battery. About the only damage the pipe line facilities suffered in this section of the lower Texas coast was to field booster pumps or compressors and minor damage to microwave repeater tower reflectors.

tember 15, when too many suppliers turned gas into the system. Because of lack of communications, Tennessee Gas dispatchers were unable to contact production men to cut back on the oversupply of gas, and as a result, "had gas running out our ears."

Pipeliners help Civil Defense. Few men are as well trained as pipeliners to take emergencies in stride. Partly, this can be explained by the fact that emergencies are common in pipe line construction and operation, and pipeliners are used to facing them. Moreover, pipeliners have the habit of success; they get the job done with whatever tools or materials are available.

Texas Eastern Transmission Corporation pipeliners played an important role in Civil Defense activity in the path of the storm as it roared inland.

Their radio-equipped automobiles provided communicatons after the wind had destroyed telephone lines, disrupted power supplies in the Cuero, Texas, area. The district master electrician, Don Strain, was able to reach two hospitals in the area and start the emergency generators. Other Texas Eastern pipeliners played important roles in minimizing loss of life and damage to property in other locales.

One of the interesting aspects of the pipeliner's part in the Civil Defense effort was summed up by one of Texas Eastern's district foremen. He pointed out that his crew had alternate plans for carrying out assignments during the storm—depending on the directon of the wind.

As a result of its activity in the storm area, Texas Eastern headquarters has received many letters expressing gratitude to those the pipeliners helped.

Transcontinental Gas Pipe Line Corporation also played an important role in Civil Defense. Some 40 to 50 persons sought refuge from the storm at the company's El Campo compressor station. They stayed in the warehouse and shop during the worst part of the storm.

Just how pipeliners behave in a storm the size of Carla is exemplified by this incident. A number of Houstonians were playing cards and imbibing in "schnapps" while waiting out the hurricane, when a gust of wind, blew down a tree and damaged the gas light in the front yard. One of the wags called the gas company "just for the heck of it." Surprisingly, within 10 minutes a crew of pipeliners was on hand, repaired the light in short order.

When Dr. John C. Freeman, Jr., weather consultant to Tennessee Gas, was asked about the size of Carla, he said, "At one time, the storm occupied most of the Gulf of Mexico. Its eye was about 30 miles in diameter, and the barometric pressure at the storm's center was recorded at 28.12 inches of mercury. Velocity of the wind was recorded as 140 mph; and one competent observer estimated that the wind velocity near the eye reached 173 mph in the vicinity of Port O'Connor.

"Carla was certainly one of the most severe storms of the past century."

When asked what precautions should be taken to withstand hurricanes, Freeman said, "For anyone living near the coast, the most important thing is to know just where he is located with respect to salt water. He should know both the elevation above sea level and the distance from the shore line. Several fatalities probably resulted from this lack of understanding.

"A second important factor is to know the elevation of escape roads. Will they likely be flooded and how quickly?

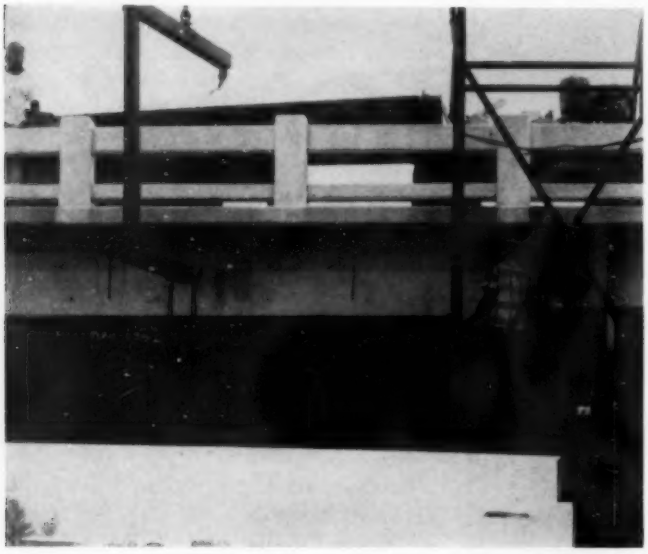
"Such knowledge is easy to come by. You can get it from any number of government agencies. And it is important enough to save your life."

—The End

How to do it

PIPE LINE HINTS

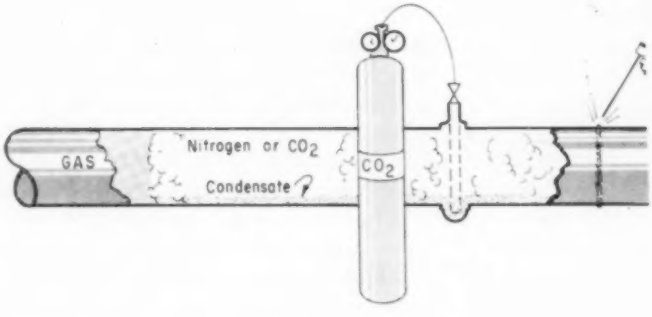
$10 is paid for each illustrated acceptable contribution. Mail to The Editor, PIPE LINE INDUSTRY, P. O. Box 2608, Houston 1, Texas



"C" Frame Sets Pipe Under Bridge Overhang

The problem was to lay the joints of pipe on the underside of the bridge. To get the pipe beneath the overhang, pipeliners fabricated the "C" frame shown here. It was made of steel plate and of box-type construction. Note that the frame is balanced to hang in an upright position when not loaded.

The joints of pipe are swung at balance point; the slings loop onto the two hooks on either side of the frame.



Nitrogen or CO_2 Used To Prevent Flash Backs

In these days of continued gas system expansion, making tie-ins or revisions in compressor station gas piping is a common occurrence. If you've had the problem of extending a gas header by welding an additional length of pipe to it, you know that once the air gets to the inside of the pipe, there is a great likelihood of flash back as the air-gas mixture ignites.

In one case, a 1,200-ft, 24-inch header which had been in gas service and was wet with condensate and distillates, had to be extended at both ends. As the beveling machine made the first cuts, there was only localized burning, because no air was inside the line. But as the job progressed, the header flashed from end-to-end.

The solution to the problem was to open existing valves near either end and inject nitrogen into the line. Once a sizeable quantity of nitrogen had been injected, the bottles were allowed to bleed slowly into the header until the jobs were completed. No further flashbacks were experienced.

Spade Is Easy to Find When it's in Right Place

For those who like to call a spade a spade—and put it someplace where it's easy to find, take the above idea from one of our readers.

This is a simple way of keeping track of your spade and also it keeps it out of the way. By welding a small piece of pipe on the pipe rack, you can slip the spade in and out of the 2-inch sleeve. Also, you won't lose it on a bumpy road.

WHAT'S HAPPENING IN PIPE LINE CONSTRUCTION

By **Donald G. DePugh,** Construction Editor

Transcontinental Gas Pipe Line Corp. Lets Contracts on 175 Miles of 36-Inch

Transcontinental Gas Pipe Line Corporation has awarded contracts on over 170 miles of 36-inch loops in Mississippi, Alabama, Georgia, South Carolina, Virginia, North Carolina, and Maryland.

River Construction Corporation, Latex Construction Company, J. P. Neill & Company, Inc., and Williams Brothers Company will lay the lines starting this month. Completion is set for December.

River has one spread consisting of 26 miles in Jefferson Davis, Merrian and Covington counties, Miss., and 17 miles in Clark and Choctaw counties, Ala., and a second spread with 16 miles in Chilton and Choosa, Ala., and 16 miles in Heard, and Coweta counties, Ga. This includes a crossing of the Choosa River.

Latex work includes 15 miles in Walton and Oconee counties, Ga., and 21 miles in Anderson and Greenville, S.C.

Williams Brothers will lay 13 miles in Rowan and Davidson counties, N.C., and 23 miles in Campbell, Appomattox and Buckingham counties, Va. Neill has 26 miles in Montgomery, Howard and Baltimore counties in Maryland.

Transco also has over 200 miles of 30 and 36-inch loops underway in several states which was let earlier.

Humble Plans Products Line Expansion in Texas

Humble Pipe Line Company plans an expansion of 270 miles of 6, 8 and 10-inch products lines extending from Baytown refining area to San Antonio and Austin areas.

The new line also will deliver products to intermediate points along the system. The system will have three remotely controlled pump stations and a capacity of 17,000 barrels per day. The system will include 12 miles of existing 10-inch, 165 miles of 8-inch, 93 miles of 6-inch line. From Baytown the 10 and 8-inch lines extend westerly about 177 miles. From there, a pair of 6-inch lines will be laid 43 miles to Austin and 50 miles to San Antonio.

Construction is planned to start immediately with completion set for early next year.

British Columbia Company Granted Pipe Line Permit

Authorization was granted to British Columbia Oil Transmission Company Ltd., for construction of about 75 miles of crude lines in British Columbia.

The $2.5 million project will consist of 66 miles of 8-inch trunk line from Blueberry oil field to Western Pacific Products and Crude Oil Pipelines, Ltd,. station near Taylor. Also 11 miles of 4-inch gathering lines are planned. Western Pacific is laying a line from Taylor to Kamloops.

Contract for construction of the line has been awarded to Pioneer Pipeline Contractors Ltd., and completion is set for December.

Capacity of the system will be 14,000 barrels per day.

Texas Power & Light Plans 200-Mile Gas Line

Texas Power & Light Company plans to build a gas pipe line system of about 200 miles of 4 thru 16-inch in Texas.

It will extend from Anderson County area in East Texas to points in North Texas. From Anderson's Bethel field, a 100-mile 16-inch main line will extend to Merit in Hunt County. From Merit, a 30-mile, 10-inch line will go to Savoy in Fannin County and a 30-mile, 10-inch line will go to McKinney-Denton area near Dallas. Also about 75 miles of 6-10-inch gathering lines will be built.

Pacific Gas and Electric Plans 44-Mile Gas Lines

Pacific Gas and Electric Company will lay 44 miles of gas lines to connect wells in Sutter and Colusa Counties, California. The gathering lines, from 3 to 20 inches, will take gas from Grimes, Buckeye, and Kirk areas. It will start near Grimes, cross the Sacramento River and connect with PG & E 20-inch Westside line near Dunnigan. It will cost $2.3 million.

Texaco Exploration Plans 22-Mile 8-Inch Line

Texaco Exploration Company has applied before the Alberta department of mines and minerals for approval of a 22-mile, 8-inch crude and condensate line in Alberta. The line would extend from the Rimbey station to Westerose oil field. It will supplement the existing 12-inch line and will take condensates from Rimbey gas plant.

Texas Eastman Products Line Under Construction

Texas Eastman Company, a division of Eastman Kodak Company, has started construction on its 275-mile, 6-inch, products line from Longview to Clemens Dome near Sweeny, Texas. O. R. Burden is constructing the first two sections of the line—207 miles. The third section, 68 miles, will be let later.

The line will transport propane from Phillips Petroleum Company at Clemens Dome to Texas Eastman's plant in Longview. The first sections under construction start from Longview and extend south. Brown & Root, Inc., is engineering the project for Eastman.

Lone Star Constructing 14-Mile, 8-Inch Gas Line

Lone Star Gas Company is building a 14-mile, 8-inch gas pipe line in Oklahoma. It extends from near Ardmore to Glenn.

Monsanto Lets Contract On Products Pipe Lines

Monsanto Chemical Company has awarded contract to Monical and Powell, Inc., for construction of over 190 miles of 3,4 and 6-inch products lines in Texas.

Lines will run from Monsanto's planned plant at Chocolate Bayou to

Stratton Ridge and Texas City. Three lines of 3,4, and 6-inch will be placed in one ditch to Stratton Ridge. Three 4-inch and a 6-inch line will be laid in a single ditch to Texas City. Bechtel Corp. has engineering on pipe line and new plant.

Tennessee Gas Granted FPC Approval for More HP.

The Federal Power Commission has granted Tennessee Gas Transmission Company authorization to construct 18,300 additional horsepower on its Kinder, La. to Portland, Tenn. gas line.

The $6.1 million project will be constructed in lieu of Tennessee's proposal to lay 157 miles of loop lines which had been authorized in 1959, but never built.

Tennessee will boost its capacity by 100 MMcf of gas daily for service to its New. England customers.

Michigan Wisconsin Lets Contracts to Somerville

A contract has been awarded Somerville Construction Company to lay 26 miles of 30-inch gas line in Ottawa, Allegan and Berrien Counties, Michigan for Michigan Wisconsin Pipe Line Company.

United Gas Crossing Let to Latex Construction

United Gas Pipe Line Company has awarded a contract to Latex Construction Company for a 16-inch river crossing of about 1,250 feet near Petal, Mississippi.

Service Pipe Line Plans 21-Mile Line

Service Pipe Line Co. will lay a 21-mile, 4-inch natural gas liquids line from the Hudson Gas & Oil Port Arthur plant to tie-in with Dixie Pipe Line Company. Service will build and operate the system which will have one station.

Pure Plans 10-Mile Crude Line in Texas

The Pure Oil Company will lay a 10-mile, 6-inch crude line from Frankston field, Anderson County, Texas, to the main line at Bullard station. Pure also plans 17 miles of 4-inch gathering lines in Frankston field.

PROPOSED PIPE LINE CONSTRUCTION

Here in convenient summary form is Pipe Line Industry's listing of company, line size, length, service, location and project status.

* indicates that this item is a new entry or that status of this project has changed since last appearance.

U.S.

American Petrofina, 133 miles, 6-inch, products, Mount Pleasant, Texas to Grapevine, Texas, $2.5 million, planned.

Algonquin Gas Transmission Co., Boston, 25 miles, 20-inch; 8 miles, 8-inch, gas, and 12,000 hp addition in Massachusetts, $6 million, FPC Authorization.

Ashland Oil & Refining Co., Ashland, Ky., 24 miles, 6-inch, crude, Blaine to Catlettsburg, Ky., planned.

Border Gas Transmission Company, 300 to 400 miles, gas, gathering, in South Texas, $10 million, planned.

California Gas Transmission Company, Los Angeles, (subsidiary of Tennessee Gas Transmission Company), 292 miles, 20-34-inch gas, from Mexico-California border near Mexicali, to Los Angeles and 10,000 hp. to tie into Texas Mexico-California line, $50 million, before FPC and California Public Utilities Commission.

Coastal Transmission Corp., Houston, 71 miles, 3 to 10-inch, gas, laterals; 5,500 hp in stations at Port Lavaca, Texas and Eunice, La. and 1,500 hp at Robstown, Texas, $7 million, FPC authorization.

Colorado Gas Transmission Co., 250 miles, 20-inch, gas, Southwest Colo., to Colorado Springs, before Colorado PUC.

Colorado Interstate Gas Co., Colorado Springs, 140 miles, 34-inch, gas, Green River, Wyo.,-to-Provo, Utah; 109 miles, 26-inch, Texas Panhandle to southeastern Colorado, 136 miles, 34-inch, southeastern Colorado-to-Pueblo, Colo.; 107 miles, 30-inch, Pueblo-to-Denver, $91 million, FPC conditional authorization.

Colorado Oil & Gas Corp., Denver, 400-miles, gas, from Gubik field to Fairbanks, Alaska, planned.

Columbia Gulf Transmission Company, Houston, 97 miles, 30-inch, loops in Kentucky, Tennessee, Mississippi and Louisiana; 29 miles, 12-inch lateral in Louisiana, $15 million, before FPC.

El Paso Gas Supply Company, El Paso, Texas, 228 miles, 30-inch, gas, main, Live Oak to Sutton County, Texas, $30 million, before FPC.

El Paso Natural Gas Company, El Paso, 199 miles, 30-inch, Permian-San Juan crossover loop, before FPC.

34 miles, 20-inch, Puckett to Goldsmith, before FPC.

23 miles, 20-inch, Goldsmith to Eunice-Plains line, before FPC.

9 miles, 20-inch, Goldsmith-Plains loop, before FPC.

43,600 hp in new and existing stations in Texas, Oklahoma, New Mexico and Utah, before FPC.

400 miles, 34-inch, Salt Lake City, Utah, to California border, FPC conditional authorization.

35 miles, 8-inch, gas, to deliver gas to Southern Union Gas Company in Dallas, $1 million, before FPC.

Equitable Gas Company, Pittsburgh, Pa., 31 miles, 16-inch, and 26 miles, 20-inch, in West Virginia and Pennsylvania, $5 million, before FPC.

Great Northern Pipe Line Co., 64 miles, crude, extension to Lignite field, North Dakota, planned.

Houston Texas Gas & Oil Corp., St. Petersburg, Fla., 235 miles, 2-6-inch, gas laterals, 30,000 hp in five new stations; $16 million, FPC authorizations.

* **Humble Pipe Line Company,** Houston, 270 miles, 6,8,10-inch, products, Baytown to San Antonio and Austin, Texas, planned.

Kansas-Nebraska Natural Gas Company, Hastings, Neb., 165 miles, 2-8-inch, gas, extension from Alliance, Neb., to Chadron, Crawford, Hemingford, Hay Springs, Gordon and Rushville, Neb., before FPC.

45 miles, 2-3-inch, gas, in Kansas, approved by Kansas Corporation Commission.

2,000 hp addition at Scott City, Kan., FPC approval authorization.

2,500 hp addition at Holcomb, Kan., before FPC.

Lone Star Gas Company, Dallas, 47 miles, gathering lines in Palo Pinto, Erath and Stephens counties, Texas, planned.

Lone Star Gathering Company, Dallas, 63 miles, gas, gathering, in DeWitt and Victoria counties, Texas, $2½ million, planned.

Long Island Pipeline Company, New York, 75 miles, 20-inch, products, Linden, N. J., to Long Island, N. Y., $30 million, planned.

Lo-Vaca Gathering Co., (Coastal States Gas Producing Co.) 230 miles, 6-20-inch, gas, gathering, Live Oak to Lavaca County, Texas, planned.

Matador Pipe Line Corp., Denver 175 miles, crude, from Bottineau, Burke and Renville counties, N. D., to Cromer, Man., Canada, $4 million, proposed.

Michigan Wisconsin Pipe Line Company, Detroit, 88 miles, gas, 3,000 hp, take gas from Northern Natural at Janesville, Wis., before FPC.

Mid-American Pipe Line Co., 405 miles, 10-inch, LPG, Superior, Wis., to Chicago, $12 million, considered.

100 miles, LPG, extension from Ogden City, to Charles City, Iowa, planned for 1962.

* **Monsanto Chemical Company,** 190 miles, 3,4,6-inch, products, Alvin to Stratton Ridge and Texas City, Texas, contract let to **Monical and Powell, Inc.**

Monterey Gas Transmission Company, Houston, 216 miles, 30-inch, gas, Clear Lake, Texas, to Alexandria, La., planned.

New Haven Pipeline, Inc., products line, New Haven, Conn. to Springfield, Mass., $2.5 million, planned.

Northern Natural Gas Company, Omaha, 50 miles, gas line, 2,000 hp, before FPC. 99 miles, gas, 4,660 hp, $8.9 million, before FPC.

Northern Gas Products Co., (subsidiary of Northern Natural Gas Co.), 350 miles, 8-inch, LPG, Bushton, Kan., to Des Moines, Iowa, $12 million, planned.

Northwestern Refining Co., crude gathering system, Rival and Lignite fields, North Dakota, $625,000, Public Service Commission approval.

Ohio Fuel Gas Co., 59 miles, gas, 4-24-inch main lines, in Belmont, Carroll, Cuyahoga, Fairfield, Logan, Lorain, Marion, Muskingum, Stark and Wayne counties, Ohio, $5.1 million, planned.

Oklahoma Illinois Gas Pipeline Co., (Fish Engineering and Pan American Petroleum Corp.) 550 miles, gas, Woodward, Okla., to St. Louis, planned.

Pacific Gas & Electric Co., San Francisco, 120 miles, 30-inch gas loops, Topock to Milpitas, before FPC.

44 miles, 3-20-inch, gas, gathering, in Sutter and Colusa Counties, Calif., $2.3 million, planned.

Pacific Lighting Gas Supply Co., Los Angeles, 24 miles, 16-inch, gas, Gaviota to Goleta, Calif. $1.7 million, before Public Utilities Commission.

Panhandle Eastern Pipe Line Co., Kansas City, 305 miles, 30-inch, 40 miles, 26-inch, gas, loops, and 43,000 hp, and gathering facilities, $60 million, before FPC.

200 miles, 22-24-inch, gas, lateral, from Elk City, Okla., to Haven, Kan., $15. million, before FPC.

Olympic Pipe Line Co., 324 miles, 6-16-inch, products, Ferndale, Wash. to Portland, Oregon, $17.5 million, planned.

Pennsylvania Railroad, products pipe lines along railroad's right of way to serve Friendship Airport in Baltimore and Washington's National Airport, Andrews Air Force Base, and Dulles International Airport, considered.

Phillips Pipe Line Co., Bartlesville, Okla., 75 miles, main line, 85 miles, gathering crude, from Camrick field, Gray, Okla., to Phillips, Texas, planned.

Southern California and Southern Counties Gas Cos., Los Angeles, 93 miles, 34-inch, California-Nevada border to Newberry, Calif.

St. Lawrence Gas Company, Inc., Ogdensburg, N. Y., 75 miles, gas, main, United States-Canadian border to Ogdensburg, N. Y., $3.4 million, FPC approval.

Suwanee Pipe Line Co., (Sinclair Oil Corp.) Atlanta, 800 miles, 22-inch, products, Baton Rouge to Greensboro, N. C., planned.

Tennessee California Gas Transmission Company, (subsidiary of Tennessee Gas Transmission Co.), 100 miles, 26-inch, gas, gas fields in South Texas to Texas-Mexico border near Reynosa, before FPC.

Tennessee Gas Pipeline Co., Houston 167 miles, 30 and 36-inch loops in Ohio and Pennsylvania, and 36,800 hp in 4 new and 3 existing stations, $38 million, before FPC.

18,300 hp in 3 new stations, $6 million, FPC authorization.

50 miles, 26-inch loop in Kentucky, FPC authorization.

21 miles, 16-inch, 2 miles, 12-inch, gas, offshore Louisiana, Vermilion blocks 46 and 64, $2.3 million, before FPC.

84 miles, 10-20-inch, gas, offshore Louisiana, FPC authorization.

Texas Eastern Transmission Corp., Shreveport, La.

66 miles, 30-inch, gas, loops, between Vidor, Texas, and Lambertville, N. J., and 33,710 hp in four existing stations, $17.5 million, temporary FPC authorization.

144 miles, gas, 46,300 hp. $27.8 million, for 1962, before FPC.

* **Texas Eastman Company,** Longview, Texas, 280 miles, 6-inch, products, Houston to Longview, contract let on 207 miles to **O. R. Burden Construction Corp.**

* **Texas Power & Light Company,** 230 miles, 6-16-inch, gas, Anderson County, east Texas to Fannin County and McKinney-Denton area, planned.

* **Transcontinental Gas Pipe Line Corporation, Houston.**

187 miles, 36-inch, loops, in Louisiana, Mississippi, Alabama, South Carolina, North Carolina, Georgia, Virginia, and Maryland, and a 4,000 hp station in Louisiana, $31 million, contracts let to **River Construction Corp., Latex Construction Co., J. P. Neill;** and **William Brothers Co.**

13 miles, 24-inch and 18 miles, 20-inch loops, Louisiana, FPC authorization. 14 miles, 16-inch laterals, 1-mile, 12-inch lateral, Louisiana, $2.1 million, FPC authorization.

29 miles, 20-inch, gas, and 2,500 hp, in South Texas to take gas from South Texas Natural Gas Gathering Co., $2.4 million, FPC authorization.

Trans-Southern Pipeline Corp., Houston, 1,080 miles, 12-inch, LPG, from Mont Belvieu, Texas, to Danville, Va., and 215-mile spur line from Atlanta to Georgia-Florida border, $63 million, planned.

Trunkline Gas Company, Houston, 97 miles, 30-inch, loops, between Longville, La., and Tuscola, Ill., 27 miles, supply laterals, and two 6,000 horsepower compressor stations, before FPC.

74 miles, 26-inch, gas, Longville to Cow Island, La., 24 miles, 18-inch, Cow Island to Gulf shore, and 24,000 horsepower, $18 million contract to **Panama, Inc.,** and **Sharman, Allen, Gay & Taylor.**

Utah Gas Pipeline Corp., 200 miles, gas, San Arroya and Bryson Canyon fields to Salt Lake City, $15 million, planned.

Valley Gas Transmission, Inc., Houston, 55 miles, 3 to 8-inch, gas, gathering, in Hidalgo, Brooks, Starr and Jim Wells counties, Texas, $15 million, before FPC.

International

ACT Oils, Ltd., Montreal, 400 miles, crude, Dawson Creek, B. C., to Bella Coola, B. C., before B. C. Government.

Ajax Alberta Pipeline Ltd., 28 miles, 10-inch, gas, main, Morinville to Westlock, Alta., planned.

Assistencia de Oleodutos du Petrobras, Rio de Janeiro, 280 miles, 12-inch, crude, Rio de Janeiro to Belo Horizonte, Brazil, planned.

Alberta Gas Products System, Ltd., 725 miles, 8-12 inch, gas liquid gathering system, to connect with Trans Mountain system for delivery to U.S. border, before Alberta Conservation Board.

Bituminous Oil Pipeline Co., Calgary, 250 miles, crude, from Athabasca tar sand plant in northeastern Alberta to Edmonton. approved.

Britamoil Pipe Line Co. Ltd., 64 miles, 8-inch, gas-liquids, Rimbey to Edmonton, Alberta, $2 million, authorized.

British American Oil Co., Ltd., Toronto, 125 miles, gas, Pincher Creek fields to Calgary, Alta., before Alberta Public Utilities Board.

* **British Columbia Oil Transmission Co.,** 75 miles, crude, Blueberry field to Taylor, B.C., $8 million, contract let to **Pioneer Pipeline Contractors, Ltd.**

Burmah Oil Co., Ltd., 850 miles, crude, 20 inch, from Nahorkatiya to Calcutta, India. Contract let on 250 miles to **Mannesmann-Saipem.**

Cartier Gas Corp. (St. Maurice Gas, Inc., and Consumers Gas Co., Toronto), 170 miles, gas, Montreal to Quebec City, planned.

Consolidated Gathering Systems, Ltd., Calgary, 198 miles, crude, Sturgeon field to Edmonton, planned.

Esso Argentina, 14-inch, crude, Neuquen to Bahia Blanca, contract let to **Techint, Inc.**

Empresa Nacional Calvo Sotelo, Madrid, Spain, 150 miles, 14-inch, crude, main line, Malaga to Puertollano, Spain, $10 million, planned.

Gas del Estado, Buenos Aires, 1,050 miles, 30-inch, gas, Comodoro Rivadavia field to Buenos Aires, $380 million, bids submitted for design and construction by Texas Eastern Transmission Corp., ENI, and an Argentine firm.

Gas Trunk Line of British Columbia, Vancouver, 250 miles, 30-inch, gas, main, Fort Nelson to Taylor, B. C., planned.

Gasversorgung Sueddeutschland, 180 miles, gas, Mannheim to Karlsruhe to Kehl and Ulm, $20 million, planned.

Hudson's Bay Oil & Gas Co. Ltd., Calgary, 41 miles, 4-8-inch, condensate, Waterton-Castle River area and Pincher Creek field to Carway to connect with Glacier system, authorized.

Hughenden Pipeline, 125 miles, products, Dick Lake gasoline plant to Hughenden Region, Alta., planned.

Independent Pipe Line Co., 2,019 miles, 34-36-inch, crude, Edmonton to Montreal, 23,000 pump horsepower, $395 million, before Borden Commission.

International Gas Co., Los Angeles, 1,800-miles, 30-inch, gas, Reynosa to Mexicali at California border, considered.

Interprovincial Pipe Line Company, 350-mile extension from Toronto to Montreal, looping line from Edmonton to Toronto, crude, $240 million, considered, products pipe line, Superior, Wis., to Chicago, considered.

90-mile, crude, Hamilton, Ont., to Buffalo, N. Y., before National Energy Board of Canada.

Kuwait Oil Co., 30 miles, 22, 24, 26-inch, crude, Minagish field to Ahmadi, planned.

Mid-Continent Pipe Lines, Ltd., 1500-mile, 30-inch crude, Edmonton to Chicago, planned.

Naphtha Israel Oil Co., 75 miles, 6-inch, gas, Rosh-Zohar field to Ashdod Yam on Mediterranean planned.

National Iranian Oil Co., 146 miles, 6 inch, crude, from Azna to Isfahan, Iran, $5 million, planned.

Northern Alberta Pipe Lines, Ltd., Edmonton, Alta., 110 miles, 10-inch, gas, main, Lac La Biche to Edmonton, $3 million, planned.

Northern Pipe Line Company, 153 miles, 16-inch, crude, from Regina, Saskatchewan, to Clearbrook, Minn., $10 million, planned.

Rhein-Donau Oletung, G.m.b.H, 185 miles, 24-inch, crude, Karlsruhe to Ingolstadt, $7.5 million, planned.

Peace River Oil Pipe Line Co., Ltd., 161 miles, 12-inch, crude, main line, Fox Creek to Edmonton, Alberta, planned.

Petroleos Mexicanos, 4, 6 and 8-inch, products, Mexico City-Puebla to Cuernavaca, planned.

1,240 miles, 34-inch, gas, Reynosa to Mexicali, Mexico, $160 million, negotiating with Tennessee Gas Pipeline Company for design and construction of the line.

360 mile, 12-inch, products, Minatitlan to Puebla and Mexico City, planned.

Products, Guadalajara to Tepic, planned.

Products, Aguascalientes to Zacatecas, planned.

6-inch, products, Guaymas to Ciudad Obregon, considered.

8-inch products, Guaymas to Hermosillo, considered.

Gas, Ciudad Carmen to Ciudad Pemex.

8-inch, crude Comalcalco to Minatitlan.

Crude, Minatitlan to Salina Cruz, contingent on proposed refinery on Pacific Coast.

149 miles, 10-inch, products, Ciudad Pemex to Minatitlan, planned.

181 miles, 4-inch, products, Mexico City to Salamanca, planned.

Pipelines of Puerto Rico, Inc., 95 miles, 8-inch, products, Penuelas to San Juan, Puerto Rico, approved.

Quebec Gas Transmission Lines, Inc., Montreal, 300 miles, gas, main, Quebec to Montreal, planned.

Rangeland Pipe Line Company Limited, 111 miles, 8-inch, crude, southeastern Alberta to Calgary, $3 million, planned.

Royalite Oil Co. Ltd., 26 miles 4-inch, products, in Alberta, authorized.

Saskatchewan Power Corp., 179 miles, 4-6-8-inch, gas, planned.

Societa Nazionale Metanodotti, 650 miles, 18-inch, crude, Genoa to Milan-Cremona-Torino, Italy, and Aigle, Switzerland, with extension to Karlsruhe and Munich, Germany, contract let on Italian portion to **Saipem.**

Societe du Pipe Line Sud-European, Paris, 432 miles, 34-inch, crude, port of Lavera to Strasbourg, with lateral extending 40 miles to Karlsruhe, Germany, underway.

Soc. Siciliana Metanadotti, gas line from Hassi R'Mel field in Algeria through Tunisia, across Mediterranean to Sicily and into Italy, considered.

Soc. Trapil, 200 miles, 12-inch, crude, La Havre to Paris, France, planned.

Standard-Vacuum Oil Company, 60 miles, 8-inch, gas, main, in South Sumatra, considered.

Ste. d-Etudes de Pipeline Intercontinetaux, Paris, 1,400 miles, 30-40-inch, gas, from Hassi R'Mel field in central Algeria across Mediterranean, through Spain, France and into West Germany, considered, Fish International Corporation making engineering and feasibility studies.

Sui Gas Transmission Co., Multan, Punjab, India, 145 miles, 8-inch, gas, from Sylhet to Dacca, East Pakistan, $9 million, considered.

130 miles, 16-inch, gas, main line, Multan to Lyallpur, planned.

Syrian Pipeline, Damascus, 500 miles, crude, from Karshuk field, Syria, to Mediterranean, planned.

300 miles, products, from Homs to tank farms in Damascus, Aleppo and Latakia, planned.

Trinidad and Tabago Electricity Commission, Trinidad, 42 miles, 16-inch, gas Penel field to Port-of-Spain, planned.

Trunk Pipelines Ltd., London, 70 miles, products, Canvey Island to Denham, Buckinghamshire, bill before Parliament. Extension of line from Denham to Birmingham, planned.

Yacimientos Petroleos Fiscales Argentina, Buenos Aires, crude line between Mendoza and Buenos Aires, considered.

NIOC Completes 520-Mile Products Line to Meshed

National Iranian Oil Company's 520-mile, 8-inch products pipe line from Teheran (Rey) Shahroud to Meshed has been completed.

Capacity of the line is 120,000 barrels from Rey to Shahroud and 154,000 barrels from Shahroud to Meshed. The system includes pump stations at Rey, Semnan, Shahroud with a station planned 170 miles from Shahroud.

Shell Oil Lets Contract to Curran

Shell Oil Company of Canada has awarded a contract to Curran Construction Limited on 25 miles of gathering lines in the Crossfield gas field in west central Alberta.

Products Pipe Lines Planned for India

A 600-mile products pipe line from Barauni to Delhi is being considered by the Indian Government.

Barauni is the terminal of India's 720-mile 14-16-inch crude line under construction from Nahorkatiya. A refinery will be built at Barauni with a capacity of 40,000 barrels.

India also is considering products lines from Madras to Cochin, about 350 miles; a 300-mile line from Bombay to Bhusaval and a 420-mile system from Bombay to Hyderbad through Poona.

Shell Completes Work On Two Small Pipe Lines

Shell Pipe Line Corporation has completed a 10-mile, 3-inch ethane gas line from Providence City to the Sheridan, Texas, cycling plant and a dual-flow 5.6-mile, 4-inch gas-condensate line from North Morales field to Providence City.

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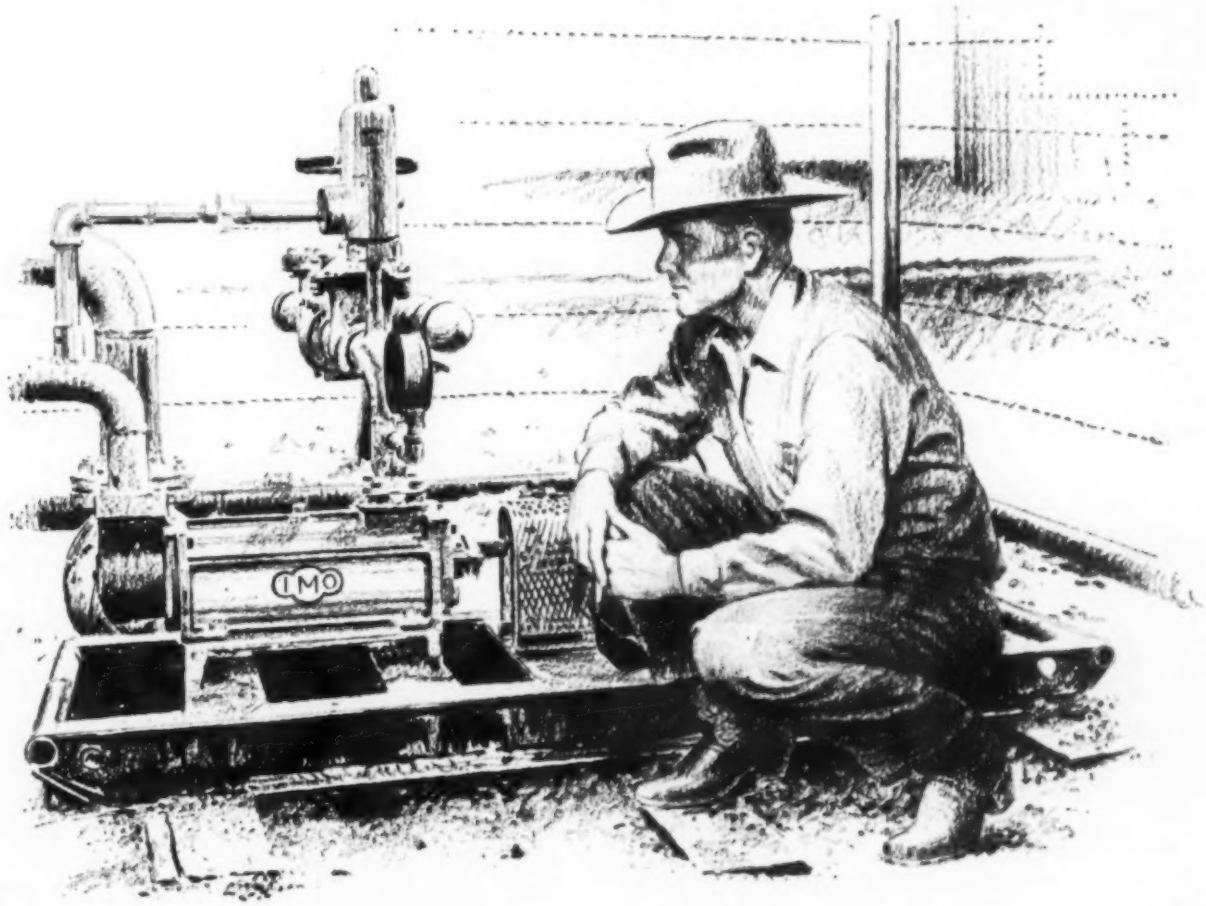

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For more data on advertised products, use cards, last page.

What's Happening

among MEN in the INDUSTRY

Executives Tour Canada-California Pipe Line

Among the several stops made by these industry executives touring the gas line under construction from Alberta, Canada to near San Francisco was the Elk River crossing in British Columbia. In the background the Elk winds through this mountainous terrain on the Alberta Natural Gas Co. section. From left to right are Ralph S. Nabors, general superintendent, Pacific Gas Transmission Co.; Joe L. Work, general superintendent, pipe line division, and John R. Kiely, senior vice president, Bechtel Corporation; Theodore B. Johnson, project manager, on Alberta Natural Gas section, Canadian Bechtel Limited; J. E. Corette, president, Montana Power Company; Donald R. McClung, president, Pacific Power and Light Company; Frank M. Warren, president, Portland General Electric Company; Norman R. Sutherland, president, Pacific Gas and Electric Company; S. D. Bechtel, Jr., president, Bechtel Corporation and J. P. Yates, executive vice president, Bechtel.

Melvin H. Rattray

Melvin H. Rattray, Jr., has been named manager of rates for **Texas Gas Transmission Corporation.** His duties will include preparation and processing of all company rate schedules and the filing of service agreements between company and its customers with the Federal Power Commission. Rattray joined the company in 1950 and had been assistant manager of rates before his promotion. Previously he served as senior accountant and senior rate accountant.

Marathon Pipe Line Company has appointed **Nelson E. Trumbull** president and a member of the board. He succeeds **Jack H. Rice** who was named vice president of supply and transportation for **Ohio Oil Company,** Marathon's parent firm.

Trumbull had been senior planning associate in Ohio's forward planning division. **Max L. Stanfield,** Rocky Mountain region manager was named vice president and director of Marathon. Trumbull has been with the company since 1936 and Stanfield joined Ohio in 1938.

Kansas-Nebraska Natural Gas Company has appointed **S. D. Whiteman** chairman of the board and chief executive officer and named **Thomas Creigh, Jr.,** president and principal operating officer. Whiteman had been president since 1946 and Creigh was vice president in charge of production, transmission and gas supply since 1951. **Frank Flagg,** who held the discontinued position of executive vice president becomes financial vice president.

Three new vice presidents were named. **Frank Soldan** general sales manager, is now vice president in charge of merchandising; **Fred Steffens,** secretary and controller, becomes a vice president; and **Stephen D. Ford, Jr.,** chief engineer, was named vice president in charge of production and gas supply. **James Asbury,** senior engineer replaces Ford and **John Asburn** was named senior engineer. An executive committee consisting of Whiteman, Creigh, and Flagg was named.

Ivan C. Wood, pipe line maintenance foreman at Nowata, Okla., for **Service Pipe Line Company** has been transferred to Mexia, Texas. He will assume the position of pipe line maintenance foreman.

Fred H. Moore, executive vice president of **Mobil Oil Company,** has been named to the board of directors of **Magnolia Pipe Line Company.** Moore joined the Mobil organization in 1935 in the Southwest as a geologist.

Humble Pipe Line Company has appointed **D. C. Lamm** area manager for the Midland area. He had been assistant area manager and succeeds **J. F. McCarthy,** who is retiring.

Lamm joined Humble in 1927 as a laborer at McKamey, Texas, on construction of the company's first line in the Midland area. He was appointed to the Midland area in 1957 and in 1960 was named assistant area manager.

Humble Oil and Refining Company has elected **Morgan J. Davis** chairman of the board and **Carl E. Reistle, Jr.,** president succeeding Davis. Reistle had been executive vice president.

Davis joined Humble in 1925 as a geologist. He was named executive vice president in 1956 and president in 1957. Reistle has been with the company since 1936. He was made a vice president in 1955 and executive vice president in 1957.

Winston J. Woellert, Houston, has been appointed manager of personnel relations for **Continental Pipe Line Company.** Woellert, who had been in **Continental Oil Company's** wage and salary administrative division will make his new headquarters in Ponca City, Okla. He succeeds **Max E. Stansbury,** who transfers to Houston as director of Continental's labor relation's division.

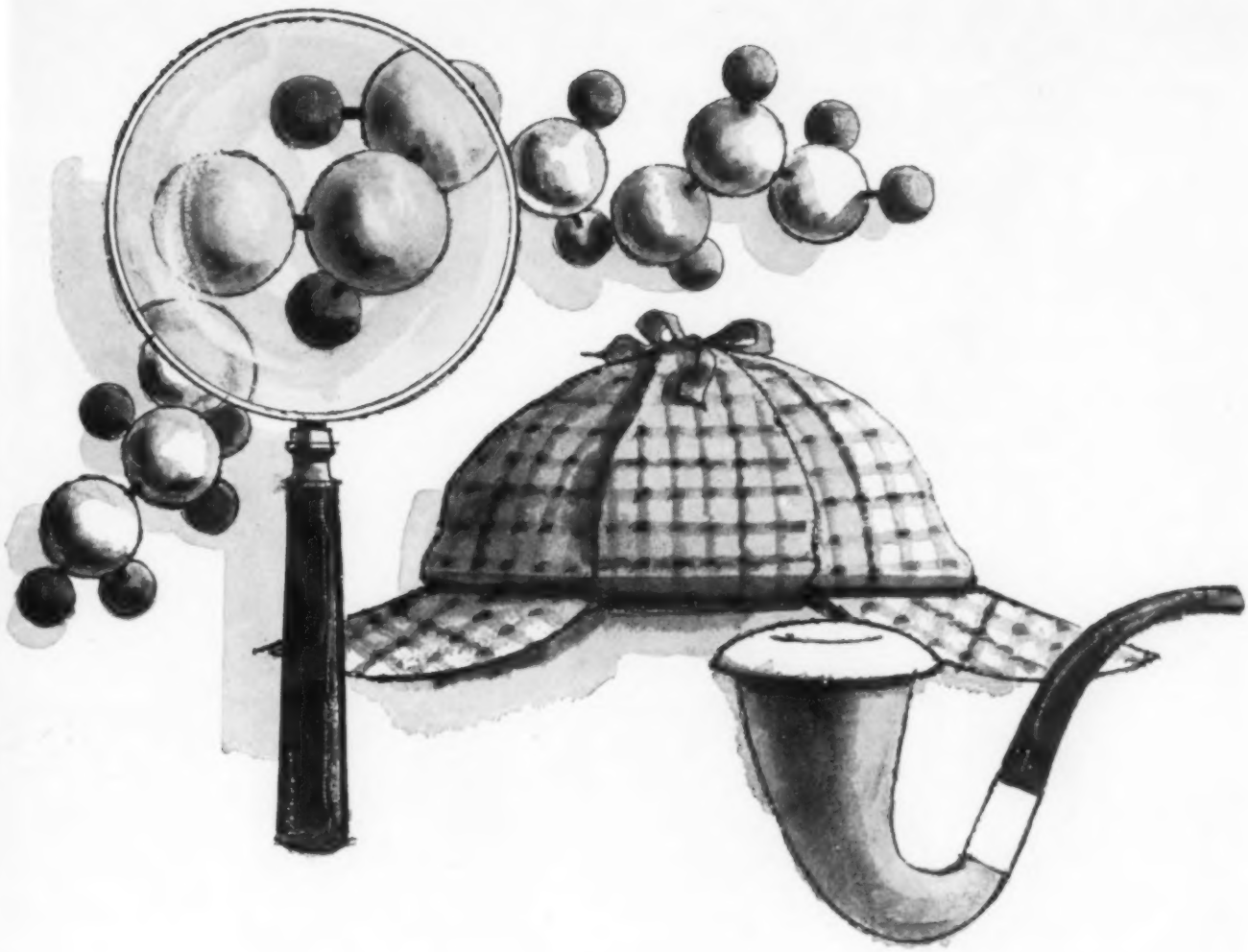
Robert E. Dorcheus, Houston, assistant to the director of the wage and salary administration division, becomes division director replacing Woellert.

Kenneth E. Manner, assistant secretary of **Cities Service Gas Company,** has been named to the board of directors. Manner has been with the company since 1957. Previously he was associated with the Federal Power Commission from 1947-1957.

John N. Schuelke has been named manager of industrial development department at the **Bank of the Southwest.** The new department will do research and make studies concerning the industrial potential of Texas and will assist companies building and locating in the state.

Schuelke had been a petroleum consultant and previously was sales manager for Johnston Testers. Before joining Johnston, he had been with Gulf Publishing Company as an editor on World Oil magazine.

Tuloma Gas Products Company of Tulsa has acquired a minority interest in **General Gas Corporation,** Baton Rouge. **H. S. Phillips,** General Gas president, said



THE CASE OF THE MISSING CARBON ATOMS

Sticky problem. Clearly not a case of theft. No evidence of foul play, either.

Whole thing started with "n-paraffins"—family of methane molecules. N-paraffins appear in crude oil and source rock—sediments in which oil was formed. Shifty, though; also crop up in rock which never harbored any oil. Very misleading to oil-hunters. How to tell one kind of rock from the other?

One piece of evidence to go on: N-paraffin molecules very careless about their make-up. Some have an *even* number of carbon atoms; others, an odd number. H-m-m-m. Any telltale ratio between the number of "even" and "odd" molecules?

One way to find out. Count the carbon atoms.

Ever count atoms? Easier said than done. Invisible, you know. Takes all kinds of latest, most advanced scientific techniques—fractionation, spectroscopy, radiocarbon dating, quick-freezing of cores. That sort of thing. Calls for first-rate scientists. Socony Mobil assigned job to task force of scientists under physicist Ellis Bray. Resourceful man, Bray. Persistent, too. Had to be—counted carbon atoms in *quadrillions* of n-paraffin molecules.

Job took lots of patience, correlation. This and a bit of shrewd deduction led science fellows right to the key. Simply this: If your count shows almost exactly as many molecules with *even* number of carbon atoms as with *odd* number, your molecules come from source rock. Good hunting ground for oil. But if "odd" molecules outnumber "even" by as little as 20 in 100, sediments not oil-bearing.

Elementary, of course. But good thing to apply to oil exploration. Can sometimes mean difference between success and failure. Big difference. Tantalizing, though, this discovery. Gives new clues to even deeper mystery—how oil formed in first place. Really *big, that one. Way it goes in this research thing.*

Lots of chaps working alongside Ellis Bray in Mobil's $25,000,000-a-year research program. Some 1,500 of them. Both sexes. Turn imagination into ideas, ideas into better products and processes. Clever.

Good thing, this probing frontiers of science. Not only for Mobil, but for everyone who does business with Mobil—customers, employees, licensees, investors.

SOCONY MOBIL OIL COMPANY, INC.
150 E. 42nd St., New York 17, N. Y.

Mobil

POLYKEN PROTECTION—METHOD OF PROVEN PERFORMANCE

Seadrift coating job rated tops over the years...so company comes back for more...and more

1954—ORIGINAL HAND-APPLIED TEST INSTALLATION, 12 miles of 8" pipe

1957—ANOTHER SEADRIFT INSTALLATION, 31 miles of 6" pipe
1960—STILL ANOTHER SEADRIFT INSTALLATION, more than 300 miles of 6" and 8" pipe
1960—ANOTHER MAJOR PRODUCTS PIPELINE INSTALLATION, on 8" pipe

Bell hole examination convinces second firm, too, to make important use of Polyken protection!

Proof of dependable performance . . . most graphic endorsement of Polyken. In 1954, Seadrift Pipeline Co. test-installed gas pipeline from Bee County to Seadrift, Texas, wrapped with Polyken #900 Black. Very satisfactory cathodic protection requirements on the line made Polyken tape the choice again on a job from Live Oak County to Seadrift in 1957.

In 1960, a bell hole examination of the original job showed Polyken tape still in top-rated condition after 6 years. No pipe rust or corrosion. No time-wear or deterioration of tape. So, fully convinced Seadrift officials put Polyken protection to work on their 1960 projects. And engineers from *another* major pipeline company, equally impressed, ordered this *proven performance* coating for an important part of their new products line in Iowa.

This kind of performance adds to the growing list of Polyken tape users some of America's most exacting firms. Get full details on Polyken performance and economy from your Polyken representative, or write Polyken Sales Division, 309 West Jackson Blvd., Chicago 6, Ill.

Polyken®

EXPERIENCED IN PROTECTIVE COATINGS

THE KENDALL COMPANY
Polyken Sales Division

For more data on advertised products, use cards, last page.

POLYKEN
PROTECTIVE
COATINGS
DISTRIBUTORS

Atlanta, Georgia
Steele & Associates, Inc.

Billings, Montana
Western Corrosion Service

Chicago, Illinois
Sales Engineering, Inc.

Cicero, Illinois
Midland Pipe & Supply Co.

Cincinnati, Ohio
Hare Equipment

Cleveland, Ohio
The Harco Corp.

Denver, Colorado
Patterson Supply Co.

Houston, Texas
Cathodic Protection Service

Jackson, Michigan
Utility & Industrial Supply Co.

Kansas City, Missouri
H. J. Hodes Co.

Long Beach, California
Barnes & Delaney

Memphis, Tennessee
General Pipe & Supply Co.

Minneapolis, Minnesota
Simcoe Equipment Co.

New Orleans, Louisiana
L. F. Gaubert & Co.

Philadelphia, Pennsylvania
Harold N. Davis Co.

Plainfield, New Jersey
Stuart Steel Protection Corp.

San Francisco, California
Incandescent Supply Co. of Calif.

Spokane, Washington
Jan-Tan Corp.

St. Louis, Missouri
Corrosion Products, Inc.

Tulsa, Oklahoma
Midwestern Pipe Line Products Co.

Polyken
Experienced in modern PROTECTIVE COATINGS

that the management and operations of the company would not be changed.

Tom K. Davis, formerly vice president of **Tennessee Gas Pipeline Company**, was named president and a director of **East Tennessee Natural Gas Company**. Davis succeeds **John C. Bolinger, Jr.**, who has been president since 1957. Bolinger will continue on the East Tennessee board and is being promoted to a new executive post with **Tennessee Gas Transmission Company**.

Tom K. Davis

In 1937, Davis joined Northern Natural Gas and in 1946 he became a dispatcher with TGT. When Tennessee Gas Pipeline Company, a division of TGT, was formed in 1959, he became a vice president.

William W. White, a section head in **Service Pipe Line Company** engineering department, has been temporarily assigned to Casper, Wyo. He assumes duties of **R. H. Christman**, division chief engineer, who is on special assignment in North Dakota.

WHO'S MEETING WHERE

October

AGA, 43rd annual convention, Statler Hilton Hotel and Municipal Auditorium, Dallas, October 1-4.

University of Kansas, ninth annual gas measurement institute, National Guard Armory, Liberal, Kansas, October 3-4.

NACE, Western Region Conference, Hotel Multnomah, Portland, Ore., October 4-6.

Gas Compressor Engine Short Course, University of Oklahoma, Memorial Union Building, Norman, Okla., October 5-6.

Southwestern Legal Foundation, third national institute for petroleum landmen, Dallas, October 5-7.

NACE, North Central Region Conference, Chase Park Plaza Hotel, St. Louis, October 9-11.

Seventh Annual Petroleum Seminar and annual **Quartermaster Association** national convention, Biltmore Hotel, Atlanta, Ga., October 11-13.

California Natural Gasoline Association, annual fall meeting, Lafayette Hotel, Long Beach, Calif., October 12-13.

ASME-ASLE, lubrication conference, Morrison Hotel, Chicago, October 17-19.

Rocky Mountain Oil & Gas Association, annual convention, Denver-Hilton Hotel, Denver, October 18-20.

National Society of Professional Engineers, fall meeting, Hotel Roanoke, Roanoke, Va., October 19-21.

American Society for Metals, 43rd national congress, Cobo Hall, Detroit, October 23-27.

Pipe Line Institute, Southwest Kansas Center, Court House, Liberal, Kansas, October 24-25.

NACE, South Central Region Conference and exhibition, Shamrock-Hilton, Houston, October 24-27.

NGAA, Southern Regional meeting, Carlton Hotel, Tyler, Texas, October 27.

National Lubricating Grease Institute, annual meeting, Rice Hotel, Houston, October 29-November 1.

NACE, Northeast Region Conference, Hotel Statler, New York City, October 30-November 2.

November

Society of Automotive Engineers, national fuels and lubricants meeting, Shamrock Hilton Hotel, Houston, November 9-10.

API, annual meeting, Chicago, November 13-15.

NGAA, Panhandle Plains Regional meeting, Herring Hotel, Amarillo, Texas, November 17.

ASME, annual meeting, Statler Hilton Hotel, New York City, November 26-December 1.

NACE, Southeast Regional conference, and Florida General Conference, Key Biscayne Hotel, Key Biscayne, Fla., November 27-Dec. 1.

December

Interstate Oil Compact Commission, annual meeting, Denver Hilton Hotel, Denver, December 4-6.

1962

January

Pipe Line Contractors Association, annual convention, Boca Raton Hotel, Boca Raton, Florida, January 7-10.

March

NACE, 18th annual convention, Municipal Auditorium, Kansas City, Mo., March 19-23.

April

PIEA-PESA, annual convention and exhibit, Dallas, April 10-12.

ASME, oil and gas power division conference, Shoreham Hotel, Washington, D. C., April 15-18.

AGA, Transmission Section, and SGA, annual convention, Houston, April 30-May 2.

For more data on advertised products, use cards, last page.

What's Happening among SERVICE and SUPPLY MEN

Mineral Fiber Mfg. Corp. Formed with Simpson President

Robert E. Simpson has been appointed president of the newly formed Mineral Fiber Mfg. Corp. which has headquarters in Houston. Other officers include Dr. W. P. Bonin, vice president; J. P. Bristow, vice president; and George Hillyer and James A. McBride, directors.

Robert E. Simpson

The new firm's primary product will be glass fiber pipe line felt. Simpson formerly was regional manager for L-O-F Glass Fibers Company. Other product manufacturing is contemplated by the company.

Minnesota Mining Announces Vice Presidential Appointments

Minnesota Mining and Manufacturing Co. has named Raymond H. Herzog and Harry Heltzer vice presidents. Also E. J. Kane, A. H. Redpath and R. W. Adam have been appointed divisional vice presidents.

Heltzer has been with the company for 28 years and was named division vice president for reflective products in 1959. Herzog, who joined the company in 1941, became a division vice president in 1959. Kane becomes division vice president of the printing products division; Redpath of the retail tape and gift wrap division; and Adam for industrial tape division.

Gibson Named Houston Manager For Jones and Laughlin Steel

J. B. Gibson has been appointed Houston Sales district manager for Jones and Laughlin Steel Corporation. He will have supervision of Midland and Dallas and his territory includes Texas and New Mexico.

Gibson joined the company in 1949 as a storeman in Shreveport and became a special representative for pipe line projects in 1955.

Wall Appointed Tapecoat Assistant General Manager

J. Russell Wall has been named assistant general manager of the Tapecoat Company. Wall joined the company in 1952 and when the Tapecoat Company of Canada was formed in 1958, he was placed in charge of Canadian operations at the plant in Rexdale, Ontario.

Harold J. Picard has been named manager in Canada to replace Wall.

Robert J. Becker Joins Pipeline Products, Inc.

Robert J. Becker has been appointed to the sales staff of Pipeline Products, Inc. Becker will handle sales and services in the Houston area. He had been with the E. W. Robinson Supply Co.

Gulf States Asphalt Company Expands Production Facilities

Through an association with Trumbull Asphalt Company of Delaware, Gulf States Asphalt Company has expanded its production facilities for manufacture of pipe enamel #434-X. Expansion increases to 17 the number of plants where the product is made.

Kaiser Appoints King Washington Representative

Richard C. King has been named Washington representative for Kaiser Steel Corporation. He will be located in Kaiser's new Washington office which is being opened in order to provide closer liaison and better service to government agencies for which Kaiser Steel is fulfilling defense contracts.

Bucyrus-Erie Names Waack Sales Promotion Manager

Donald W. Waack has been named manager of sales promotion for Bucyrus-Erie Co. He had been assistant sales development manager for Schield Bantam Co. for eight years.

Allis-Chalmers Appoints T. D. Lyons Vice President

Allis-Chalmers Manufacturing Company has elected T. D. Lyons, comptroller, vice president, administration, industrial group. Lyons has been with the company since

All You Want In A Small Ditcher

Vermeer Model W-3

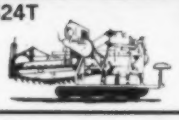
POW-R-DITCHER

FAST! RUGGED! HYDRAULIC!

Digs 3" to 12" Widths

Equipped with 18 hp. engine, the rugged Model W-3 POW-R-DITCHER is ideal for contractors, municipalities, utilities and custom operators. Rubber-tired wheels or crawler tracks. Hydraulic drive system — no shifting. 2-way dirt conveyor. Ask for a demonstration.

PICK THE POW-R-DITCHER TO FIT YOUR NEEDS

524T 

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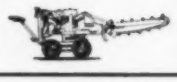
W-1 

3P

Please send me FREE information and prices on the complete Vermeer line of self-propelled POW-R-DITCHERS.

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FIRM.....

ADDRESS.....

CITY..... STATE.....

☐ Also include information on new Vermeer hydraulic back filler.

VERMEER MANUFACTURING COMPANY

1403 W. WASHINGTON • PELLA, IOWA

Write for Bulletin

PIPELINE VENTS AND MARKERS

PATENTED

FLEET-LINE CO.

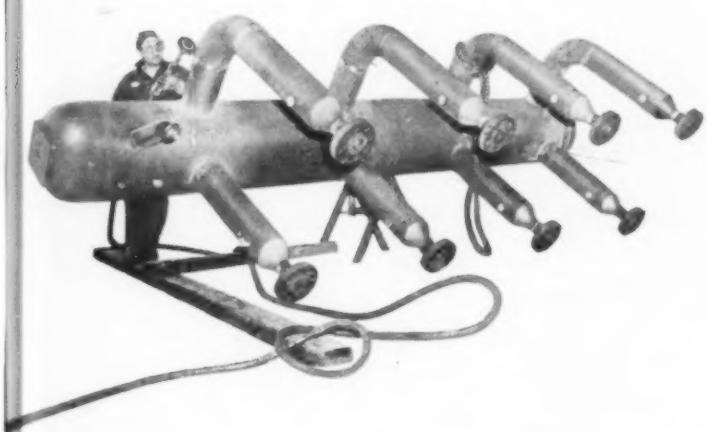
P. O. BOX 276-K

SHREVEPORT

LOUISIANA

Compressor Headers by Midwest

Fabricated to your specification ... extruded or welded design ... in any weldable metal



These compressor headers, fabricated for United Fuel Gas Company's compressor station at Coco, W. Va., are typical of the precision and quality of Midwest workmanship.

Upper header, formed of 24" O. D. x 1¾" thick rolled and welded Grade B carbon steel plate, has eight 8" extruded outlets reducing to 3" 1500 lb. flanged ends, and one 8" and one 3" full-size flanged outlets.

Lower header, of same diameter and wall thickness, contains eight 8" extruded outlets reducing to 3" 1500 lb. flanged ends, one 4" outlet, plus a 24" x 6" extruded cap.

This station, operating at 2000 lb. pressure, comprises five 880 HP and one 1100 HP gas engine compressors.

Midwest can produce headers to your exact specifications, in either welded or extruded type, and will gladly offer assistance on manufacturing and metallurgical problems.

New 36-page brochure, PIPELINE FITTINGS, describes Midwest fittings and fabricated piping for pipelines. FREE!

MIDWEST PIPING A Division of Crane Co.

1450 South Second St., St. Louis 4, Mo.

1937 and was named comptroller in 1954. W. S. Pierson will replace Lyons as comptroller. Pierson has been with Allis-Chalmers since 1940. Succeeding Pierson as assistant comptroller is E. A. Spika, who has been with the company since 1934 and in 1960 served on special assignment with C. W. Schweers, vice president and assistant to the president.

Electro-Lease, Inc., Formed by W. B. Campbell

W. B. Campbell announces the formation of a new firm to sell, lease, and service industrial communications equipment. The company, Electro-Lease, Inc., is located at 3927 Essex in Houston.

Campbell is president and Joe E. Rogers is vice president and sales manager. Campbell has been vice president and director of technical services for F. H. Maloney Company. Electro-Lease will handle wired and wireless industrial communications systems and combinations of these for intra-plant and extended communications systems. It also will offer engineering design for custom applications, including sound systems with paging and intercommunications features.

A. O. Smith Changes Division's Name

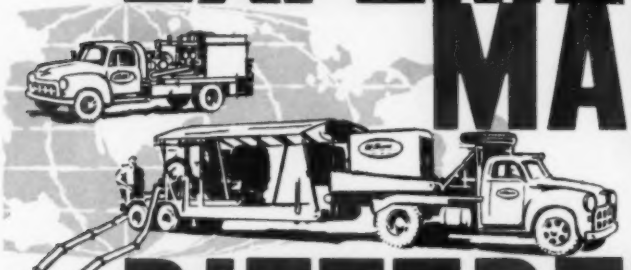
A. O. Smith Corporation's Reinforced Plastics Division has changed its name to the Glass Fiber Prdoucts Division. The division, since its inception in 1958, has widened activities and will branch out into numerous other industries and products.

Clark Bros. Co. Names Buffalo Branch Office

Clark Bros. Co. has named Charles P. Clark, Jr., manager of its newly established Buffalo office. Clark had spent four years in the Pittsburgh office as sales manager. Previously he served six years as a salesman with the firm's Detroit agents.

HYDROSTATIC PIPELINE TESTING

EXPERIENCE MAKES THE DIFFERENCE



...and a world of experience in testing thousands of miles of pipelines makes the difference in every Williams testing job.

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PRESSURE SERVICE COMPANY

Call Shreveport 423-8565
2000 BECK BUILDING
SHREVEPORT, LOUISIANA

SPECIALLY DEVELOPED EQUIPMENT • EXPERIENCED TESTING ENGINEERS

COMPLETE TESTING SERVICE

L. T. Hanse

L. E. Schade

Link-Belt Speeder Announces Three Managerial Appointments

Link-Belt Speeder Corporation has announced three mangerial appointments involving Lyle T. Hanse, Dave Van de Roovaart and Lynn E. Schade. Hanse will be assistant sales manager while Van de Roovaart was named to newly created post of field manager for credit and collections. Shade becomes special sales development representative in Europe.

Dave Van de Roovaart

Hanse has been with the company since 1950 and in 1960 he joined the Link-Belt distributor in Louisiana as branch manager. Van de Roovaart joined the firm in 1936 and he became assistant sales manager in 1957. Schade, who joined Link-Belt in 1956, was named district sales representative for Link-Belt Speeder (Canada) Ltd. in Quebec and Ontario.

Roots-Connersville Opens Branch Office in Midland

Roots-Connersville Blower, Division of Dresser Industries, Inc., has opened a branch office in Midland, Texas and LeRoy C. Laycock has been appointed manager. Laycock had been in the Houston office. Laycock will handle the entire line of Roots air and gas handling equipment.

Koehring Company Elects Mertz Member of the Board

Orville R. Mertz has been named a member of the board of directors of Koehring Company. He is financial vice president and treasurer. He joined the company in 1953 as controller and was promoted to vice president of finance in 1955.

Clark Bros. Co. Names Four Sales Engineers

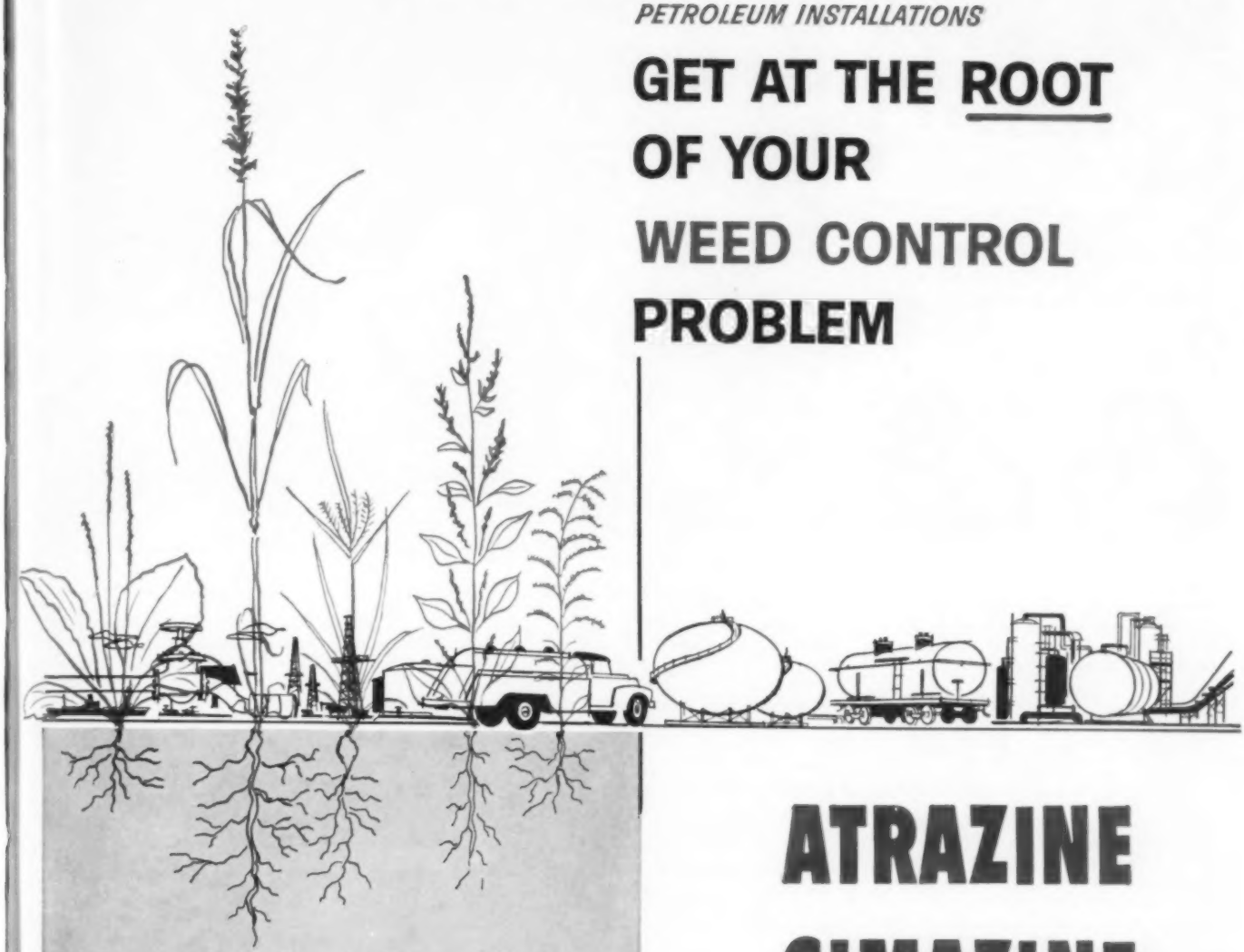
Clark Bros. Co. has appointed four sales engineers on Clark engines, compressors and turbines. M. S. Kenady was named to the Amarillo office. Z. B. Deer was appointed to the Tulsa office. Edward S. Leonard was assigned to Houston and Thomas R. Bett was appointed to the Shreveport office.

Kenady has been in sales engineering in gas-petroleum industries since 1945. Deer had been in Amarillo office two years. Leonard has been in application engineering, sales engineering and marketing for Clark in Olean, N. Y. for over 10 years. Bett has been an application engineer in Shreveport for four years.

GEIGY—creators of chemicals for modern agriculture

PETROLEUM INSTALLATIONS

GET AT THE ROOT OF YOUR WEED CONTROL PROBLEM



ATRAZINE
SIMAZINE

HERBICIDES

Geigy industrial herbicides make possible full season weed control from one application.

Atrazine or Simazine controls both broadleaf weeds and grasses—are non-irritating and low in toxicity to humans and animals. Both provide ease and economy in use.

Plan now to get at the root of your weed control problem. Your supplier has Geigy industrial herbicides in wettable powder or granular form. For free information call him today or write—Geigy Agricultural Chemicals, Division of Geigy Chemical Corporation, Saw Mill River Road, Ardsley, New York.

Geigy ORIGINATORS OF DDT INSECTICIDES

GEIGY AGRICULTURAL CHEMICALS

Division of Geigy Chemical Corporation • Saw Mill River Road, Ardsley, N.Y.

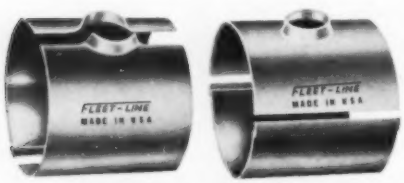
FLEET-LINE
WELDING FITTINGS

LITERATURE BY Air Mail

Code fittings; domestic materials. All orders acknowledged by air-mail or long distance phone and filled at once.

REDUCERS: Concentric and Eccentric, 1" through 30". ASA B16.9, ASTM A234. Schedules 10 to 160, X and XX heavy, stainless steel, chrome-moly and other alloys, genuine wrought iron, copper, aluminum. Special lengths and sizes without delay.

SADDLES, conventional, and for pressure vessel heads. Nozzle sizes from ¼" through 24" with skirts to any size. FLEET-LINE saddles weld neatly into place in much less time and with much less welding rod.



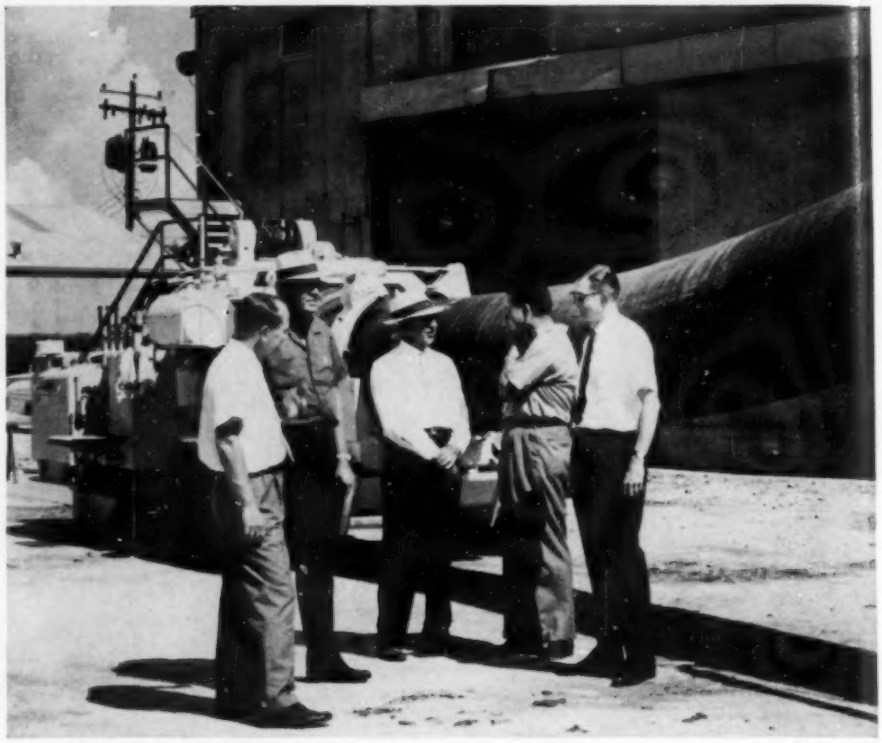
FULL-ENCIRCLEMENT SADDLES, nominal pipe sizes 2" through 36". Five types.

REDUCING TEES, Forged Steel, 8" through 30".

MADE IN U.S.A.

STEEL FORGINGS, Inc.

P. O. Box 276 K Shreveport, La.



Pipeliners Inspect Bending Machine

Gathered around a bending machine at Crose-Perrault Equipment Corporation's Houston yard are from left to right, Ben Montgomery, vice president, Crose-Perrault; W. A. Page, El Paso Natural Gas Company; Parker Boggs, Colorado Interstate Gas Company; T. B. LaRock, El Paso; and W. H. Schroeder, Jr., A. O. Smith Corporation. Crose-Perrault was demonstrating bending machine used with internal line packer.

Crosby Valve & Cage Given Exclusive Rights

Exclusive sales right to market valve test stands and equipment designed and manufactured for Crosby Valve & Cage Company by Piping Engineering Company were granted to Crosby. The agreement gives Crosby a complete line of test benches for firms desiring to test and reset valves after repair work or periodic inspection as required by inspection codes.

AiResearch Names Fletcher Gas Turbine Sales Manager

Robert A. Fletcher has ben named to the newly created post of sales manager—industrial gas turbines for AiResearch Manufacturing Co., a division of the Garrett Corporation.

Fletcher joined AiResearch in 1959. He had been sales manager for Solar Aircraft Co. This is the second appointment in expanding industrial gas turbine field in recent months. James T. Shore was named program manager of industrial gas turbines earlier.

Texas Instruments Appoints Chicago Regional Sales Manager

Guy W. Wilson has been named regional sales manager of Texas Instruments Incorporated Industrial Products groups with headquarters in Chicago. Wilson has been with the company for four years and formerly was sales engineer in Cleveland and Chicago.

Daniel Orifice Transfers B. C. McKnight to Dallas

B. C. McKnight has been transferred from the Houston office to Dallas office as district sales representative for Daniel Orifice Fitting Company. The Dallas office is located at 828 Fidelity Union Life Building. McKnight has had 10 years experience at Daniel in production, engineering and sales. He will serve customers in the northeast Texas area.

Dorcon Incorporated Formed To Make Tanks and Vessels

Dorcon Incorporated, a subsidiary of Dorr-Oliver Incorporated, has been formed to design, manufacture and erect metal tanks, storage facilities and vessels.

Alex Fino has been named president; K. Earl Abel, treasurer; and John W. Swick, secretary. Max G. Walker will be sales manager with headquarters in Pittsburgh.

CLASSIFIED ADVERTISING

TRADEMARK and lettering decals made for your trucks, equipment, small quantities or more. Write for Catalog. Mathews Co., 827 S. Harvey, Oak Park, Ills.

Manuscripts Wanted

Have you written a book you would like to have published? Do you have an idea or an outline that you would like to talk over with a publisher? Gulf Publishing Company, publishers of World Oil, Hydrocarbon Processing & Petroleum Refiner and Pipe Line Industry magazines, and numerous technical books, is actively seeking trade and technical manuscripts for publication by its rapidly expanding Book Division. For further information write to Manager, Book Publishing, Gulf Publishing Company, P. O. Box 2608, Houston 1, Texas.

fleet service for Walworth LPV's

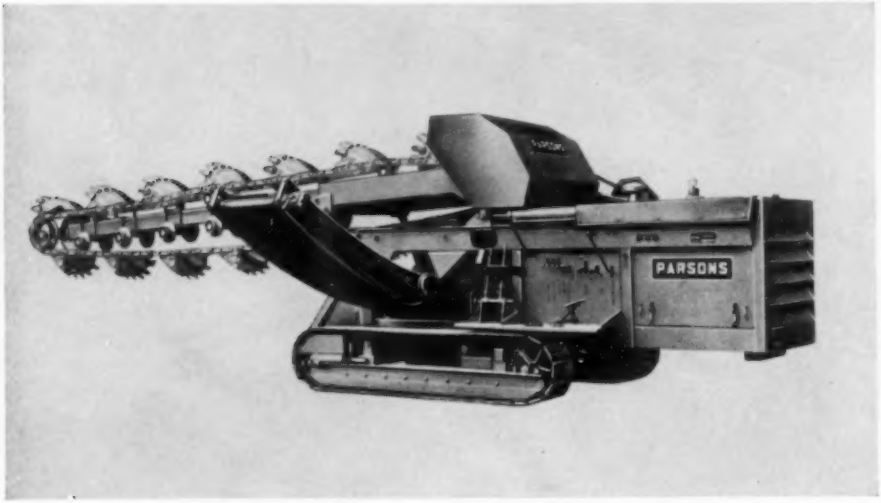
Walworth's own fleet of service wagons is on call around the clock. Each of these self-contained, highly mobile service units is fully outfitted with specially-designed equipment to perform routine and special lubricated plug valve service . . . at the job site. Back country and rough terrain are all part of the day's work for these speedy wagons. Wherever your Walworth Lubricated Plug Valves may be, count on Walworth's Service Fleet to get there . . . fast.

WALWORTH **WALWORTH**

LUBRICATED PLUG VALVE DIVISION: 3517 POLK AVE., P.O. BOX 18211, HOUSTON 23, TEX. EXECUTIVE OFFICE: 750 THIRD AVENUE, NEW YORK 17, NEW YORK

WALWORTH SUBSIDIARIES: Alloy Steel Products Co. ■ Conoflow Corporation ■ Grove Valve and Regulator Co. ■ M & H Valve & Fittings Co. ■ Southwest Fabricaitng & Welding Co., Inc.

What's New in EQUIPMENT

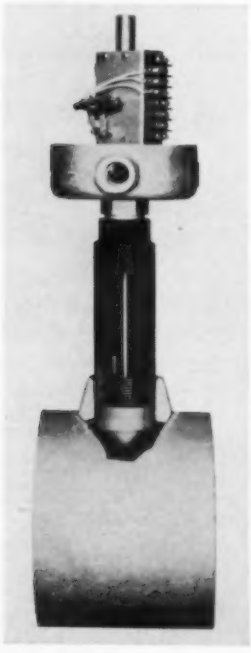


Parson Trenchliner

A new ladder type trenchliner for cutting an 18 to 48-inch trench up to 15 feet deep has been introduced by the Parsons Company, division of Koehring Company. The Model 255 has a low silhouette with only 9-foot, 2-inch height and 7-foot, 10-inch width outside crawlers. This allows close-quarters trenching and truck transportability without disassembly or special permits.

The unit features hydraulic actuation of steering and bucket line clutches to permit quick response to depth variations and to hold close grade tolerances. Bucket line is hydraulically adjusted.

For more data, circle **No. E1** on Readers' Service Card, last page this issue.



Pig Indicator

A pig or scraper indicator that can remotely start or stop pumps on liquid line has been introduced by Magnetrol, Inc. The unit utilizes a magnet-attracting sleeve, raised or lowered by plunger, which attracts or releases a permanent magnet attached to a mercury or pneumatic switch. Hermetically-sealed switches give maximum reliability for automatic control and telemetering. Two switches are provided with the Pig-Trol so that there can be isolated, separate circuits for station operation and telemetering circuits. An extension neck is provided keeping control head above ground. Contoured sensing plunger indicates passage of pig without damage to its surface.

A vapor-proof, moisture-tight cover is standard on Pig-Trol. Magnetrol's pneumatic pilot mechanism can be substituted for standard electrical switch mechanism.

For more data, circle **No. E2** on Readers' Service Card, last page this issue.

Fiberglas Reinforcement

A new reinforcement to help enamel coatings ward off corrosive elements has been introduced by Owens-Corning Fiberglas Corporation. Glass fibers and yarns are pressed into a mat to form Coromat inner wrap—a reinforcement to keep moisture away from lines. A new binder applied to product makes it easier to handle.

When passed through the enamel, Coromat allows air and gas bubbles to escape. Fibers arranged in many directions are augmented by glass yarns to give Coromat strength from every angle.

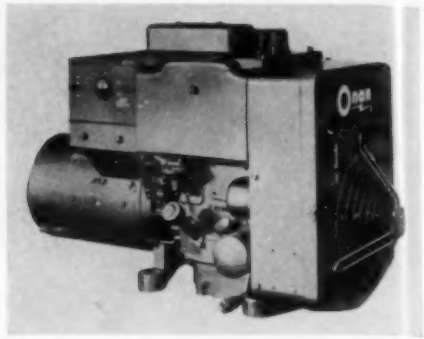
For more data, circle **No. E3** on Readers' Service Card, last page this issue.

New Line of Engines

A completely new line of industrial engines and engine-driven generators has been introduced by Onan, division of Studebaker-Packard Corporation. The engines will feature interchangeable parts, choice of gas, gasoline or diesel fueling and water-cooled or air-cooled models—all fabricated from one basic set of tooling. The "J" series is a family of 12 engines which can be produced in a variety of models with minor modifications and selection of accessories. First units in the series—which include one, two and four-cylinder models ranging from 3 to 15 kilowatts—are available this fall.

Other major developments of series include accessibility of all parts for servicing on one side of an engine, reducing maintenance and repair time; interchangeability of parts providing service centers a complete stock of parts with small inventory. Similar capacity or horsepower units have similar dimensions; vibration isolators are standard; full flow oil filter and a single engine air outlet are included.

For more data, circle **No. E4** on Readers' Service Card, last page this issue.



Scraper Trap Closure

Well Equipment Mfg. Corp., announces a new scraper trap closure featuring a unitized assembly and one-man operation. It is a hinged type closure with cap or blanking plug threaded into a special fitting which is butt welded to the trap. The cap can be swung into an open or closed position by one man. A polished rod in the cap center fits into a bushing at the end of the hinge arm so the cap turns freely when being threaded.

The cap has an "O" ring to assure positive, leakproof seal when it is tightened against the seat in the fitting. Closures are available in sizes 8 through 38-inch in ASA 150, 300, 400, 600, and 900 ratings.

For more data, circle **No. E5** on Readers' Service Card, last page this issue.

Automated Transport

Steel Pipelines

Non-stop transport via pipeline, centrally controlled and supervised.
Direct, reliable and economical delivery over hundreds of miles.
Pipelines for technical advance and high transport-safety. Cargoes valued in the millions flow through pipelines: water, gas, oil, slurries.

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Pipeline systems supplied by PHOENIX-RHEINROHR-INTERNATIONAL, Düsseldorf, Thyssenhaus.

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HOW TO SCRUB GAS AT MINUS 40° F

This is part of the Trans Canada Pipe Line which stretches from Alberta's eastern border all the way to Montreal. Keeping natural gas *clean* and *moisture-free* as it moves along the 2,340-mile length is a big job, especially when temperatures drop to 40° below zero.

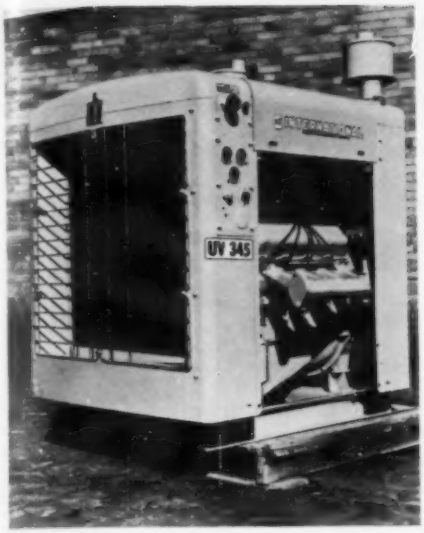
But even these unusual requirements are no problem for AAF. Six big AAF Amerclone gas scrubbers are now at work on the Trans Canada Pipe Line. One hundred 4½-inch Amerclone tubes in each scrubber maintain high collection efficiency year 'round . . . dust particles simply drop from the tubes to a hopper at the bottom. These AAF units are capable of handling 400 MMSCFD at a pressure of 850 psi—and are among the largest ever installed in Canada.

Whether your operation is in an arctic, desert or temperate region — whether your application is pumping, process, or power — AAF can help you with your air- or gas-cleaning problem. Get complete information from your nearby AAF representative; or write us direct. Address: Robert Moore, American Air Filter Company, Inc., 450 Central Avenue, Louisville, Kentucky. In Canada: American Air Filter of Canada, Ltd., 450 Stinson Blvd., Montreal 9, Quebec.

AAF **American Air Filter**

BETTER AIR IS OUR BUSINESS

For more data on advertised products, use cards, last page.

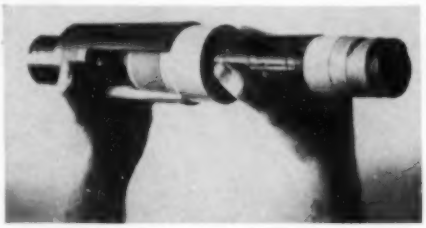


Gas Engine

A new gas engine, the UV-345, has been added to International Harvester Company's line. The compact eight-cylinder, valve-in-head unit has a stripped maximum horsepower of 194 at 3,800 rpm. Industrial engine maximum is 164 hp at 3,000 rpm and industrial engine (with fan) horsepower is 158 at 3,000 rpm.

The engine features a rigid "Y" block, Tocco-hardened crankshaft, aluminum alloy pistons and positive-type exhaust rotators. There are full-pressure lubrication and full-flow oil filtering. Cooling capacity is 29 quarts and lubricating system, including filters, is seven quarts.

For more data, circle **No. E6** on Readers' Service Card, last page this issue.



Plastic Pipe

A new plastic pipe for extreme pressure and temperature applications has been developed by the Spiral-Glas Pipe Company of Old Bridge, N. J. It is designed for use in corrosive applications at high pressures and recommended for crude oil gathering lines, salt water lines and flooding operations. The pipe consists of a glass fiber reinforced core, co-cured with and protected by liner and cover. Fibers are chemically linked with a plastic matrix based on Enjay Chemical Company's Buton A-500 resin.

Core of pipe is of filament-wound glass fibers bonded by butadiene-styrene resin. Cover and liner of pipe are made of a blend of nitrile rubber and polyvinyl chloride (ABR-PVC). Tests have shown pipe to be suitable for crude, kerosene, diesel, JP-4, jet fuel and brine all at 200° F temperature.

Presently pipe is produced in 2-inch size for 500 psi, but full scale production of 2,3, and 4-inch is planned by June 1962.

For more data, circle **No. E7** on Readers' Service Card, last page this issue.

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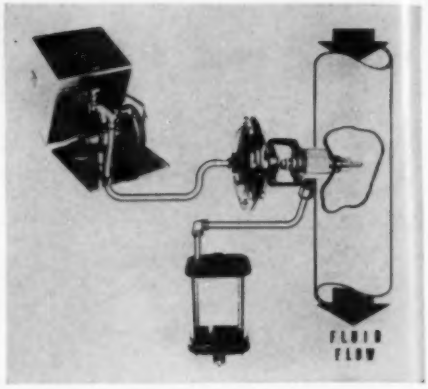
10174-CC

Bucket Teeth Tips

New longer tips have been produced for bucket teeth of three track-type loaders and two wheel-type loaders for Caterpillar Tractor Co. The long tips are of two designs—runner and digger. Runner type is for use with wheel loaders, which are normally used for loading out of stockpiles. Digger type is for track-type units used in excavation. Both are flat on one side and ribbed on the other; runners are rib side up and diggers rib side down.

Tips for wheel-type loaders (944 and 966) is 1⅞-inch longer than the current short unit and 22 percent heavier. For track-type loaders (933 and 955) it's 1⅞ inches longer, 32 percent heavier. On largest track-type loader (977) tip is 2 inches longer and 45 percent heavier. Shorter tips are still available and recommended for use in high impact applications.

For more data, circle **No. E8** on Readers' Service Card, last page this issue.

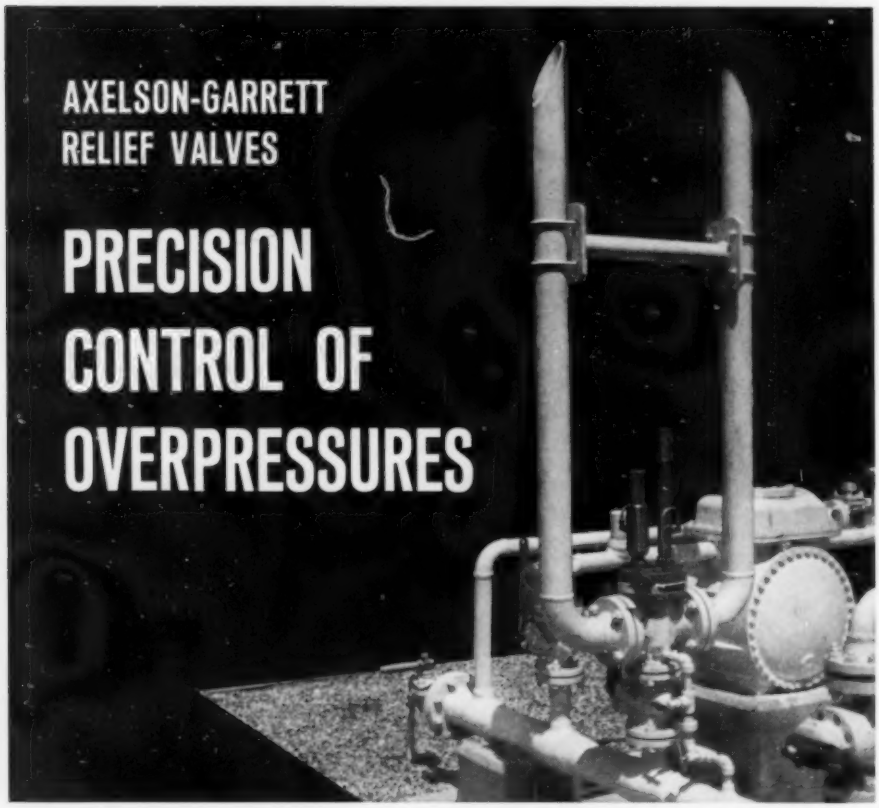


Pneumatic Liquid Sampler

A pneumatic actuated liquid sampler, which enables accurate flow line fluid sampling at the rate of 10 to 500 samples per minute, has been introduced by Odex Engineering Company. It consists of a sampler valve, sample pulser and sample container. Sample valve screws directly into the line. Pressure applied on the valve diaphragm by the pulser moves a ball in the valve between two seats. A fluid sample is taken each time ball moves from one seat to the other. Pulser is housed in a stainless steel box and may be mounted on vertical or horizontal line. It is connected to valve diaphragm by tubing. Sampler valve is linked to sample container by tubing.

Sample is taken directly from the line. Sampler operates at 20 to 30 psi and valve will handle pressures from 10 to 1,500 psi.

For more data, circle **No. E9** on Readers' Service Card, last page this issue.



Why take chances on overpressure damage to lines and vessels when you can have positive protection with Axelson-Garrett Pressure Relief Valves.? Dependable and automatic, they relieve, blow down and reseat within extremely close limits . . . often within 1% of system operating pressure . . . available in operating range of 25 to 6,000 p.s.i.

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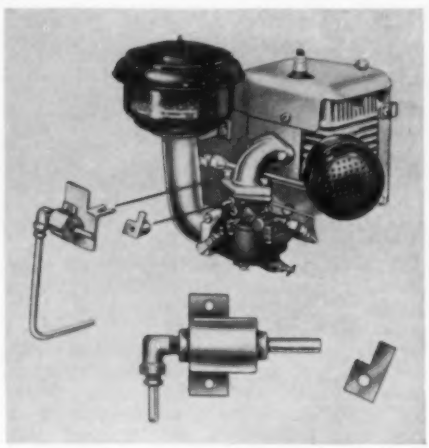
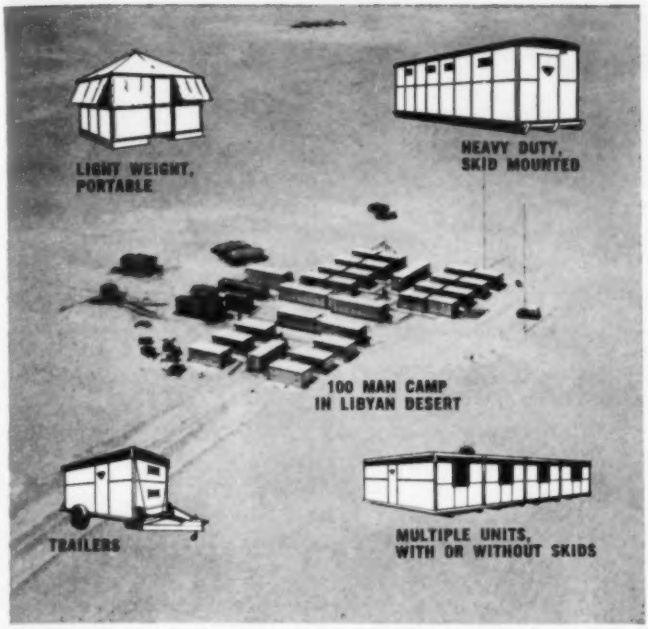


Engine Slow Down Device

An automatic slow down device for gasoline engines used on air compressors is available from Champion Pneumatic Machinery Co. The pneumatic control operates during the unloading cycle. A pilot switch and unloader valve actuates the control. During pumping cycle, pilot switch channels tank pressure to diaphragm of unloader valve, holding it closed and forcing air into tank. At same time, pressure is piped to pneumatic throttle control which overrides engine governor and opens throttle.

For more data, circle **No. E10** on Readers' Service Card, last page this issue.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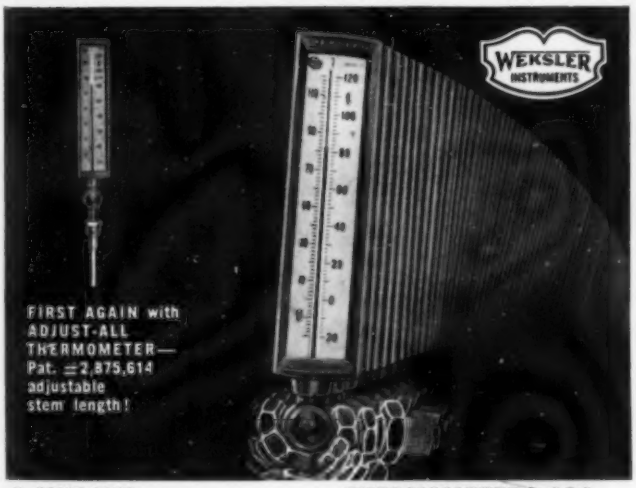

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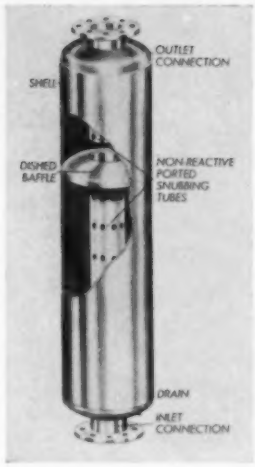
Checharoo Valve

A check valve with a clapper hinge pin which pivots the clapper out of stream for full pressure and unobstructed passage has been developed by Frank Wheatley Pump & Valve Mfr. The synthetic rubber seal check valve has a full pipe opening. The 20-degree stainless steel precision-machined clapper hinge pin assures easy action. The non-lubricated valve operates in vertical or horizontal position. It has "O" ring gaskets and valve is equipped with a pressure gage or test vent.

It is available in 2-6-inch sizes and semi-steel material. Soon it will be produced in ductile iron and steel.

For more data, circle **No. E11** on Readers' Service Card, last page this issue.

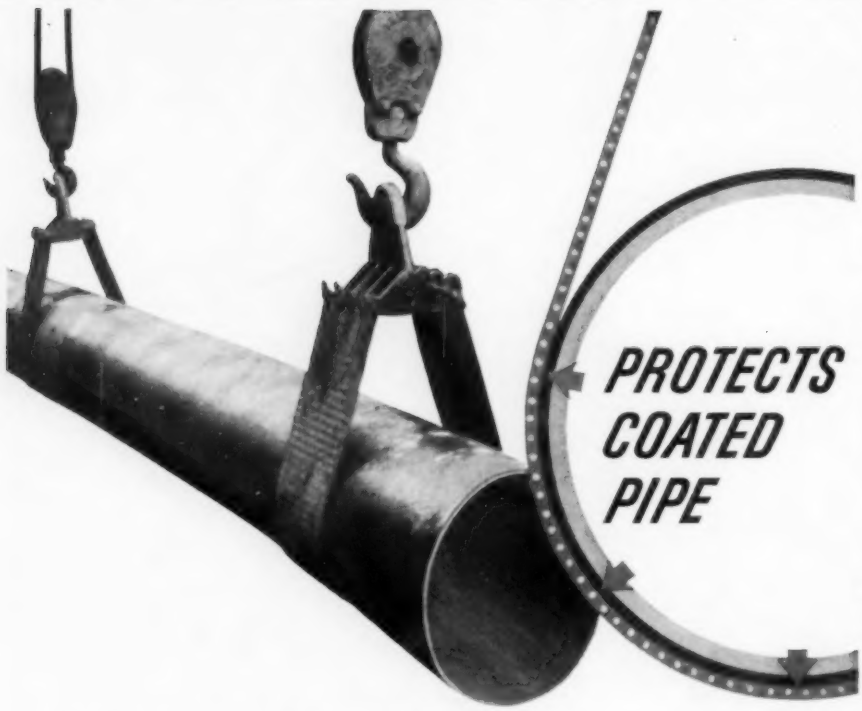


Straight Flow Snubbers

A new series of snubbers operating on straight flow snubbing principle and designed for new turbocharged engines has been developed by Burgess-Manning Company. Each one of series is for a particular level of noise suppression. They will be marketed as BMTA first-turbo line; BMTB turbo-standard; and BMTC turbo-pact. New series is in production from 8-inch through 30-inch pipe sizes and larger sizes can be built on specification.

Gas passes in a straight line through ported tubes and snubbing chambers and comes out in a quiet, smooth flow. Pressure drop across exhaust is held to a minimum, saving horsepower. There are no moving parts in the units.

For more data, circle **No. E12** on Readers' Service Card, last page this issue.



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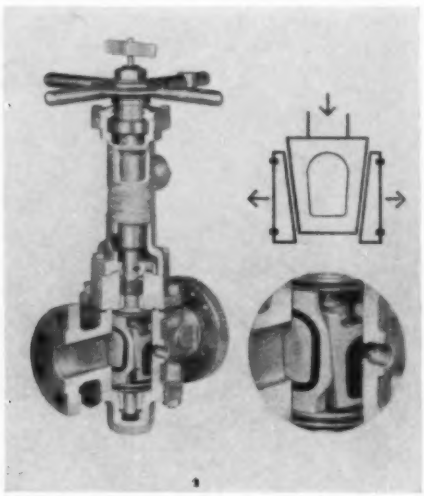

Plug Valve

General Valve Company, Inc., has developed a new twin seal Model C non-lubricated, plug type valve providing a bubble-tight seal at upstream and downstream ports with a body bleed for positive checking. Two replaceable seating segments avoid abrasive-contact of seating surfaces.

When plug moves downward, these seating segments are wedged outward to effect a double block. When plug moves up, segments retract and disengage from body seats before plug is rotated. Improvements over previous models include an enclosed packing gland, roller bearings that decrease amount of torque necessary to actuate valve, and fewer parts.

For more data, circle **No. E13** on Readers' Service Card, last page this issue.

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Centrifugally loaded wheel type brush cleaning head

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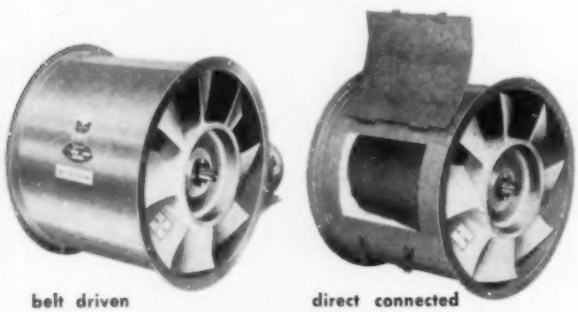

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Literature

For more data on New Equipment or copies of Catalogs and Literature reviewed in this issue, use the Reader Service postcards just inside the back cover and facing the Advertisers' Index. Simply circle code numbers of items desired—sign and mail card.

Boring Unit

A gasoline powered boring unit, Ka-Mo G-160, offered by Kwik-Mix Co., is featured in a bulletin released by Kwik-Mix. The unit range varies from 200 feet of 12-inch hole to 150 feet of 36-inch bore on horizontal or at angles up to 30 degrees from the horizontal.

The six-page, two-color bulletin illustrates and describes the unit, presents a capacity chart, and discusses in detail many of the machines various features.

To get a copy, circle **No. E14** on Readers' Service Card, last page this issue.

Dry Air System

Information on unitized dry air systems is contained in Trinity Equipment Corporation's new catalog. The system provides an economical source of super-dry compressed air with dewpoints of —100° F or lower. They are self-contained units with compressor, accumulator, dryer and necessary controls and instrumentation.

Detailed specifications and system selection charts for determining required capacity at any altitude are included in the catalog.

To get a copy, circle **No. E15** on Readers' Service Card, last page this issue.

Two-Way Radios

Tubed and transistorized VHF two-way radios in powers of 100 watts and less are featured in a new publication available from General Electric Company Communications Products Department.

Units from 10 to 100 watts are described in the 24-page brochure which is titled, "Two-Way Mobile Radio."

To get a copy, circle **No. E16** on Readers' Service Card, last page this issue.

Flow Nozzle

A two-page fact sheet is available from B-I-F Industries on its venturi flow nozzle, welded insert type, Model 134. This is a differential producing primary slow metering element for service involving high pressures, high temperatures or severe thermal stresses as in products lines.

The nozzle is provided with ends beveled or flanged for easy installation. No drilling or tapping of pipe line is required. The venturi element is contained in a section of seamless steel pipe, permitting high working pressures.

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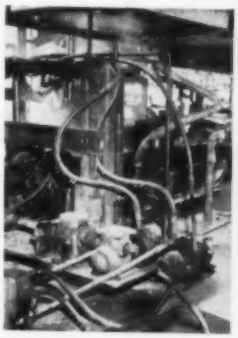
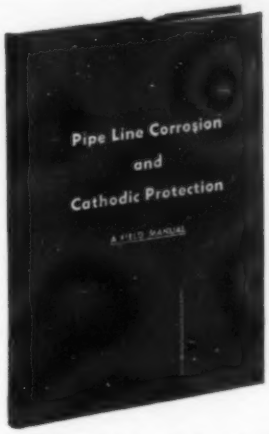


IRISH ENGINEERING SERVICE, INC.

IRISH ENGINEERING SERVICE OF ARKANSAS, INC.



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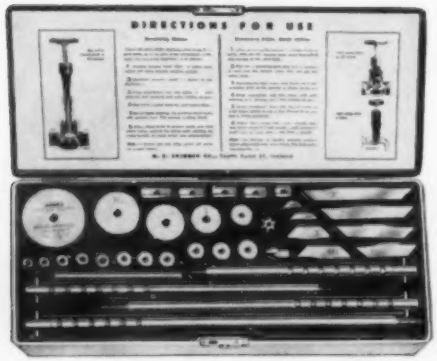


Easily pays for itself on the first two jobs!

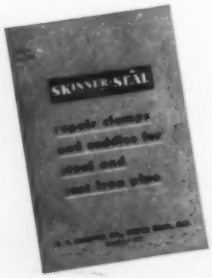
Reseats flat and tapered-seat globe or angle valves—all bibbs and faucets—in place, quickly and accurately. The saving, over tearing out and renewing leaky valves and fixtures, is tremendous.

Cutters operating under screw feed, leave worn, scored seats glass-smooth, level, absolutely accurate and tight.

A guide pilot centers each cutter; a tapered cone centers each spindle. Perfect alignment is inevitable. Cutters guaranteed. Write for literature!

2" for ¼" to 2" valves and ¼" to ¾" bibbs
List price $59.85

3" for ¼" to 3" valves and ¼" to ¾" bibbs
List price $79.50



FREE catalog showing our pipe repair clamps, saddles, and reseating tools

M. B. SKINNER CO.
SOUTH BEND 21, INDIANA

Advertisers' Index

• Dot preceding name of advertiser indicates that detailed data on products and services of the firm will be found in current (1960-61) third revision of The Pipe Line Catalog.

A

Acme-Newport Steel Co. 97
Aerovent Fan Co.
Large Propeller Division 90a
Allied Materials Corp. 20
American Air Filter Co. 84
Axelson-Garrett Division
U. S. Industries, Inc. 86

B

• Bonney Forge & Tool Works 7
• Borg-Warner Corp. 28
• Byron Jackson Pumps, Inc.
A Borg-Warner Subsidiary 28

C

• Caterpillar Tractor Co. 9
The Ceilcote Co. 85
• Clark Bros. Co.
One of the Dresser Industries 30-31
Classified 80
Columbia-Geneva Steel Division
United States Steel 22-23
Crane Co. 77
• Crose-Perrault Equipment Corp. 89b
• Crutcher-Rolfs-Cummings, Inc. 88

D

De Laval Steam Turbine Co. . . . . 34 and 71
• Dresser Electronics
SIE Division 17
• Dresser Industries, Inc. 30-31

F

Fleet-Line Co. 76b
Ford Motor Co. 24-25

G

Garlock, Inc. 8
• Gaso Pump & Burner Mfg. Co. 32
Geigy Agricultural Chemicals
Division Geigy Chemical Corp. 79
General Dynamics Corp. 26
Gould-National Batteries, Inc. 10-11
• Grove Valve & Regulator Co. 98
• Gulf Publishing Co. 91b

H

• Hydrill Co. 27

I

International Harvester Co. 16
Irish Engineering Service, Inc. 91a

J

Jones & Laughlin Supply Division 14-15

K

The Kendall Co. 74-75

L

Lone Star Steel Co. 2

M

Magnetrol, Inc. 90b
Midwest Piping
Division Crane Co. 77
Minneapolis-Honeywell 12
• Mixing Equipment Co. 29

N

National Tube Division
United States Steel 22-23
• Nicolet Industries, Inc. 6

P

Petroleum Helicopters, Inc. 89a
Phoenix-Rheinrohr AG 83
• Pipe Line Catalog 92-93
• The Pipe Line Development Co. 87c
Polyken Division
The Kendall Co. 74-75
• Porta-Kamp Mfg. Co. 87a
H. C. Price Co. 5

R

Radio Corporation of America 21
• Rockwell Manufacturing Co. 18-19

S

• SIE Division
Dresser Industries 17
• M. B. Skinner Co. 94
Socony Mobil Oil Co. 73
Solar
Subsidiary International Harvester Co. 16
• Steel Forgings, Inc. 80
Stromberg-Carlson Division
General Dynamics Corp. 26
Stupp Corp. 13

T

• Taylor Instrument Companies 33

U

U. S. Industries, Inc. 86
United States Steel Corp. 22-23
United States Steel Export Co. 22-23

V

Vermeer Manufacturing Co. 76a

W

• Walworth Co. 81
Weksler Instruments Corp. 87b
Williams Pressure Service Co. 78

For more information on advertised products and services . . . check and mail the Readers' Service postage-paid cards on opposite page

ANOTHER UNDERGROUND MOVEMENT

...in ELECTRIC WELD LINE PIPE from *Acme-Newport*

Untold miles of man-made undergrounds incorporate Acme-Newport line pipe formed from quality steel from the furnaces of this 77-year-old basic producer. This pipe is chosen because it installs trouble-free and stays that way during long years of gathering and distribution service. Every length is true round and uniform in wall thickness; bends readily, welds easily; passes a series of tough examinations by electronic, hydrostatic and visual inspectors. Available in 4″ and 6″ sizes, standard and thin wall; meets all API and ASTM specifications. For *good* line pipe, call Acme-Newport!

Acme-Newport Steel COMPANY

NEWPORT, KENTUCKY

A SUBSIDIARY OF ACME STEEL COMPANY

SIZES AND WEIGHTS AVAILABLE

O.D.	Wall	Wt. Per Ft.
4½	.125″	5.84
	.142″	6.61
	.156″	7.25
	.188″	8.64
	.219″	10.00
	.237″	10.79
6⅝	.156″	10.78
	.188″	12.89
	.219″	14.97
	.250″	17.02
	.280″	18.97

Steel

GROVE G-6 REGULAR PORT VALVE
SIMPLE—COMPACT—VERSATILE

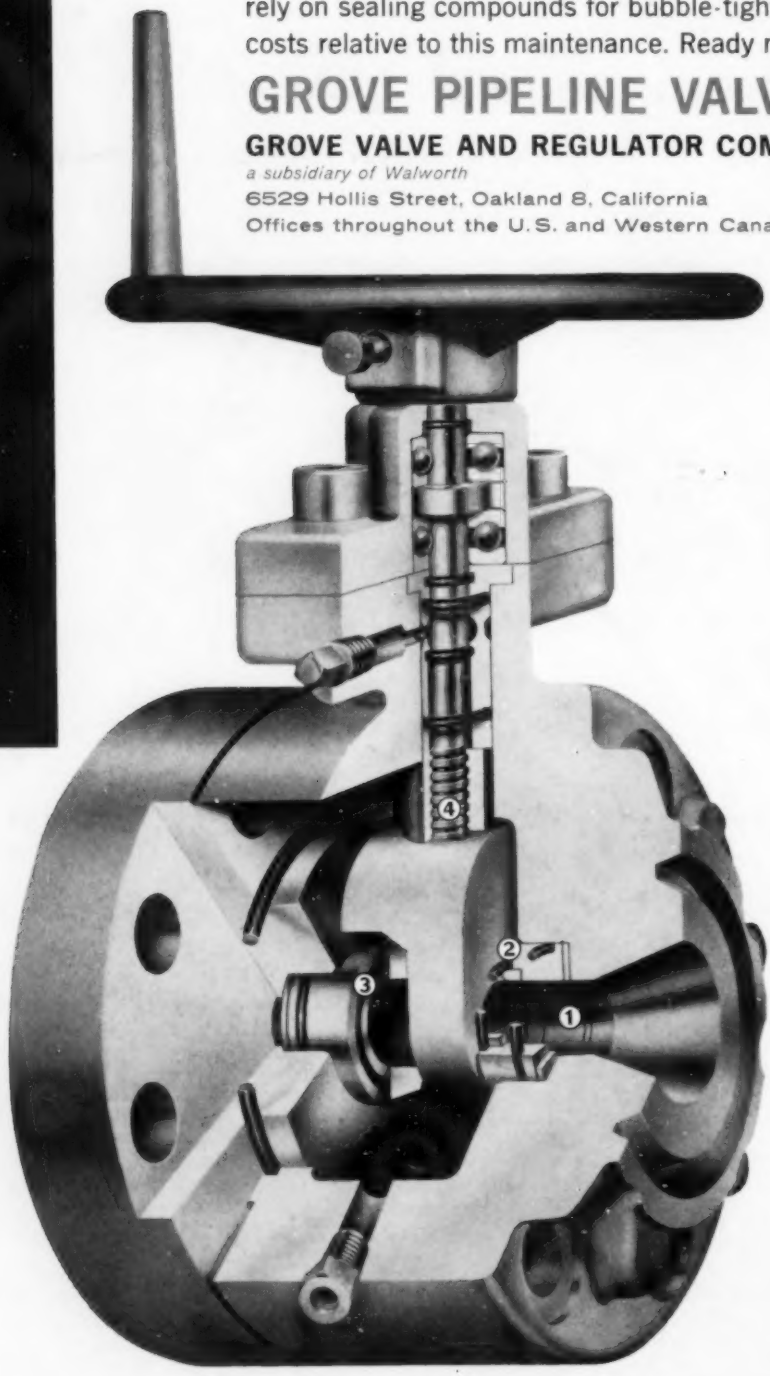
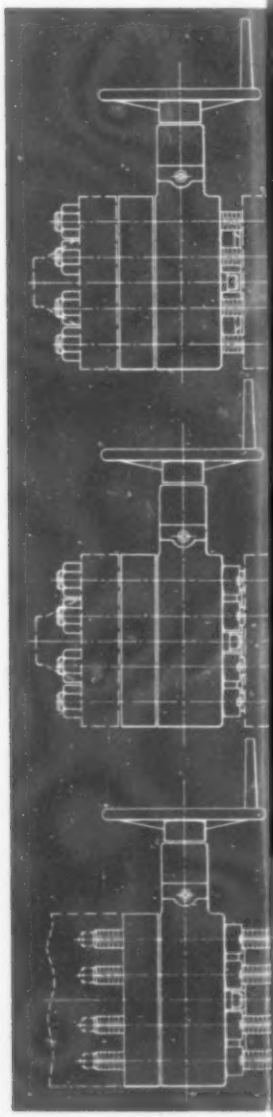
For Manifolds, Headers, General Pipeline service

Now the proven Grove Seal-"O"-Ring® design is ready in a compact regular port gate valve. Round opening (1) assures flow characteristics superior to plugs. Double-barrier seal gives positive metal-to-metal contact (2) backed up by protected o-rings (3) to keep gate clean, smooth for fast open/close. Non-rising stem (4) and "designed-in" compactness achieve overall height of only 14⅜". G-6 Regular Port gate valves, like all Grove valves, do not rely on sealing compounds for bubble-tight shut-off, thereby eliminating costs relative to this maintenance. Ready now in 2" ASA 900 and 1500.

GROVE PIPELINE VALVES

GROVE VALVE AND REGULATOR COMPANY

a subsidiary of Walworth

6529 Hollis Street, Oakland 8, California

Offices throughout the U.S. and Western Canada